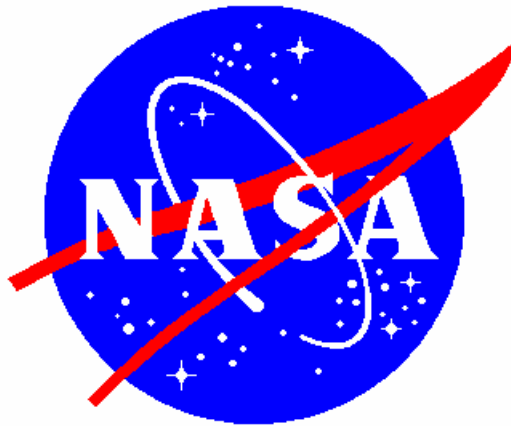


Attachment A

**SPECIFICATIONS FOR
RESEARCH LABORATORY, ROOM 317
BUILDING 77**



**NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GLENN RESEARCH CENTER
21000 BROOKPARK ROAD, CLEVELAND, OHIO 44135**

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SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under this project, as indicated on the drawings and in these specifications, consists of providing services, labor, equipment, and materials necessary to rehabilitate approximately 700 square feet for a Research Laboratory, Room 317, Building 77, at the NASA Glenn Research Center, 21000 Brookpark Road, Cleveland, OH 44135.

This scope of work for this project includes installation of new heating, ventilating, and air conditioning (HVAC), plumbing, electrical power distribution, lighting, ceilings, flooring, architectural finishes and rework of existing fire suppression systems. It also includes minor abatement of lead. The scope of work will be packaged into Base Bid and Options.

1.1.1 Metric Project

This project has been designed with the International System of Units (SI), otherwise known as metric units.

1.2 OPTIONS

1.2.1 Option 1 Window Caulking and Trim

Option 1 includes labor and material for interior window caulking and plastic laminate window trim.

1.2.2 Option 2 Sliding Door

Option 2 includes labor and material for installation of sliding glass door to lab vestibule.

1.2.3 Option 3 Epoxy Floor

Option 3 includes labor and material for installation of epoxy floor and base.

1.2.4 Option 4 Painting

Option 4 includes labor and material to paint the lab walls, ceilings and doors.

1.2.5 Option 5 Ceilings

Option 5 includes labor and material to install ceilings in research laboratory.

1.2.6 Option 6 Tepid Water System / Plumbing

Option 6 includes labor and material to install tepid water system for emergency shower/eyewash station, hand sink and plumbing to fumehoods.

This scope includes installation of water heater, plumbing (piping, drains, vents, and insulation), electrical power, emergency shower/eyewash station and misc. architectural modifications.

1.2.7 Option 7 Vacuum Exhaust

Option 7 includes labor and material to install vacuum exhaust piping for research equipment.

1.2.8 Option 8 Lighting/Receptacles

Option 8 includes labor and material to install lighting and receptacles in the research laboratory. Power for the lighting and receptacles will be from a panel on the third floor.

1.2.9 Option 9 Feeds to Research Disconnects

Option 9 includes labor and material to install conduits and wiring and disconnects for research equipment. The power to the disconnects will be from a panel located on the third floor.

1.2.10 Option 10 Grating/Plate Flooring

Option 10 includes labor and material to install structural grating and plate flooring. The scope also includes installation of a drain pan for emergency shower/eyewash.

1.3 REFERENCES (Not Applicable)

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Upon receipt of Government Furnished Equipment, the Contractor shall submit records in accordance with the paragraph entitled, "Government Furnished Property," of this section.

Submit the following items to the Contracting Officer:

- Utility Outages
- Connection Requests
- Welding Permits
- Laser Permits
- Safety Permits
- Hot Work Permits

1.5 CONTRACT DRAWINGS

The following drawings dated 10/18/04 accompany this specification and are a part thereof.

Drawing No.

Title

Architectural

CF 176645	Title Sheet
SK DEMO-A1	Demolition Plan and Details
CF 176646	Floor, Ceiling and Equipment Plans
CF 176647	Section and Details - Sheet 1
CF 176647	Interior Elevations - Sheet 2
CF 176648	Roof Curb and Roof Repair Details
CF 176649	Door and Finish Schedules and Details

Structural

CF 176650	Plate Flooring Plan, Sections and Details - Sheet 1
CF 176650	Roof Exhaust Framing Plan, Sections and Details-
Sheet 2	

Mechanical

CF 176652	Legends, Tables, Symbols, and Testing Criteria Lists
CF 176653	Partial Basement Plan - Tepid Water Supply System
CF 176654	Safety Shower/Eye Wash - Tepid Water System Schematic
CF 176655	Ductwork and Piping ReWork -Plan and Section
CF 176656	Partial First & Second Floor Plans - Piping and
Plumbing	
CF 176657	HVAC Ductwork & Equipment -Roof Plan and Fan Support
Details	
CF 176658	HVAC Ductwork Arrangement -Plan and Section
CF 176659	Piping and Plumbing Plan
CF 176660	Piping and Plumbing -Schematic Details & Diagrams
CF 176661	HVAC - Air Flow Diagram
CF 176662	HVAC Control Diagram and Sequence of Operations
CF 176663	Mechanical Equipment Schedules
CF 176664	General Mechanical Requirements and Material
Specifications	
CF 176665	Mechanical Specifications and General Notes

Fire Protection

CF 176666	Fire Protection Plan
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Electrical

CF 176667	Partial Electrical Power Plan
CF 176668	Electrical Lighting Plan
CF 176669	Electrical Power Plan and Panel Schedules
CF 176670	Electrical Roof Plan
CF 176671	Electrical Conduit Elevations
SK 106577	Electrical One Line Diagram

Contractors shall purchase drawings from vendor indicated in solicitation. Reference publications will not be furnished.

Contractor shall immediately check furnished drawings and notify the Government of any discrepancies.

1.6 WORK HOURS AND NOTICES TO PROCEED

The Contractor shall telephone the Contracting Officer's Technical Representative each morning between 8:00 a.m. and 8:30 a.m. and report the following:

- Themselves
- Company Name and Contact
- Work Area
- Number of Personnel on the job

Contractor personnel working in Building 77 shall sign-in on the Contractor sign-in board. Location of the sign-in board will be in Building 77. Exact location will be determined at start of work.

The Contractor shall require each subcontractor to comply with the above requirements in the Contractor's absence.

Standard NASA Glenn Research Center (GRC) working hours shall be defined as Monday through Friday, 7:00 a.m. to 5:00 p.m. Second shift hours at GRC shall be defined as 4:00 p.m. to 12:00 a.m. Weekend hours shall be defined as 4:30 p.m. Friday through 6:00 a.m. Monday.

1.6.1 Notices to Proceed

The construction contract shall be structured with two Notices to Proceed (NTP). These shall be issued as follows:

Initial Notice to Proceed:

This NTP shall commence all required submittals (material, equipment, schedules, Health & Safety Plans, etc...). After this NTP, and before the Contractor submits a detailed construction schedule, a meeting shall be held between the Contractor, COTR, Project Manager, Building Manager, Abatement Contractor, and Research Representatives. This meeting will discuss the coordination and implementation of the construction, the coordination of contractor personnel and building occupants/research, and any special issues/concerns. The Contractor shall then incorporate this information into the construction schedule and submit the detailed schedule to the COTR for approval prior to commencing work.

Second Notice to Proceed:

This NTP shall commence actual site construction (field work). The timing between the Initial and Second NTP shall be approximately two(2) months. The Contractor must have approved submittals on major (long lead) equipment and evidence that material and equipment have been procured (invoices, manufacturing dates, etc...).

1.7 GENERAL IMPLEMENTATION REQUIREMENTS

The entire building will be occupied during construction, thus all construction work must be coordinated such that disturbances, to the building occupants, utilities and research are minimized as described below.

During the entire course of construction, building lighting, emergency exits, smoke detection, alarms, fire protection systems, and the means of

egress for the building shall be maintained.

The only laydown or storage area available to the contractor, within the building, shall be the space within the construction area.

The existing building heating, ventilating and air conditioning (HVAC) systems shall remain operational during the construction until such time that it is necessary to remove the equipment from operation for construction activities. Downtimes shall be minimized to the fullest extent possible.

The Contractor shall be responsible for cleanup of dust and debris at the conclusion of each working day as approved by the NASA Quality Assurance Technician (QAT). Scaffolding, ladders, tools, and equipment shall be removed from the hallways each day and stored in a place, to be determined at the time of the NTP.

The building occupants and equipment shall be protected from the weather and the elements at all times during the project. Roof work shall be performed under favorable weather conditions.

All shutdowns of utilities for tie-ins shall be performed during second shift hours or weekend hours, unless otherwise written approval is obtained from the COTR. See "On Site Permits," this section for more information.

All core drilling, or use of noise generating equipment shall be performed during second shift hours or weekend hours.

1.7.1 Mechanical General Requirements

This project ties into existing ductwork from an existing 100% Outdoor Air Handling Unit, located in the basement of Bldg. 77. To perform the ductwork modifications, the air handling unit will have to be shut down for a minimal amount of time. Temporary ductwork modifications will have to be made to keep make-up air feeding other areas of the third floor (Room 318) while new ductwork is being installed.

1.7.2 Electrical General Requirements

Electrical shutdowns of existing 480 V switchboard panel for tie-in of the new breaker shall be performed during weekends only. The Contractor shall give the NASA COTR fourteen (14) days advance notice for necessary switchboard shutdowns.

The Contractor shall schedule all electrical switching and shutdowns with the NASA COTR and Building Manager, and shall inform NASA COTR of the areas affected prior to switching or de-energizing equipment. Power shall be restored by the beginning of standard working hours.

1.8 AREAS OF WORK AND WORK REQUIREMENTS**1.8.1 Research Laboratory, Offices, and Building Corridor**

Work in research laboratory Room 317 shall be done during standard working hours, unless prohibited by shutdowns or noise generating equipment. Adjacent building corridor work shall be done during second shift hours. Work required in Rooms 216 and 217 shall be done during second shift hours.

1.8.2 Roof Access

Access to the roof is by 'AUTHORIZED ACCESS'. Authorization must be obtained by Building Manager and COTR. Work can be during normal working hours if authorized.

1.8.3 Basement Access

Work in basement for the tepid water system and electrical power for new third floor power panel can be done during normal working hours.

1.9 ON-SITE PERMITS

1.9.1 Utility Outages and Connections

Due to the research activities being performed throughout the building all required utility shutdowns are critical. Work shall be scheduled to hold outages to a minimum. Utility outages and connections required during the prosecution of work that affect existing systems shall be arranged at the convenience of the Government and shall be scheduled outside the regular working hours or on weekends. The Contractor shall not be entitled to additional payment for utility outages and connections required to be performed outside the regular work hours.

Request for utility outages and connections shall be made in writing to the Contracting Officer at least 15 working days in advance of the time required. Each request shall state the system involved, area involved, approximate duration of outage and nature of work involved.

This project is subject to, but not limited to, the following list of shutdowns:

<u>SYSTEM</u>	<u>PURPOSE</u>	<u>DURATION</u> (Maximum)
Electrical	Install new breaker in 480V switchboard	Weekend
AHU	For ductwork modifications (temporary tie-ins)	Weekend

1.9.2 Laser Permits

Permits shall be required for usage of lasers (ceiling installation, site work, etc...) Permits shall be submitted at least 15 days in advance.

1.9.3 Hot Work and Confined Space Permits

<u>ACTIVITY</u>	<u>SUBMISSION DATE</u>	<u>SUBMISSION FORM</u>
Hot Work Permits	7 days prior to work	NASA Form C-7A & NASA Form C-7B
Confined Space	7 days prior to work	NASA Form C-199

Permits shall be posted at a conspicuous location in the construction area.

Burning of trash or rubbish is not permitted.

1.10 GOVERNMENT FURNISHED PROPERTY

Government will furnish to the Contractor the following property to be incorporated or installed in the work, or used in its performance.

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>AVAILABLE</u>	<u>SALVAGE RECEIVING POINT</u>
<u>1</u>	<u>Exhaust Fan EF317-1</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>
<u>2</u>	<u>Exhaust Fan EF317-2</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>
<u>3</u>	<u>Duct Silencer EF317-2</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>
<u>4</u>	<u>Duct Silencer EP317-1</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>
<u>5</u>	<u>Roof Curb EF317-1</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>
<u>6</u>	<u>Roof Curb EF317-2</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>
<u>7</u>	<u>Transformer</u>	<u>1</u>	<u>Oct 2004</u>	<u>NASA GRC</u>

1.11 SALVAGE MATERIAL AND EQUIPMENT

Items of material designated by the Contracting Officer to be salvage shall remain the property of the Government.

It shall be segregated, itemized, delivered, and off-loaded at the Government designated storage area located at the Glenn Research Center.

Contractor shall be responsible for storage and protection of salvaged materials and equipment until disposition by the Contracting Officer.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01315

PROJECT MEETINGS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

A Project Submittal Schedule shall be submitted in accordance with paragraph entitled, "Project Meetings," of this section.

1.4 PRECONSTRUCTION CONFERENCE

The Contractor shall attend a preconstruction conference scheduled by the Contracting Officer Technical Representative. Work shall not commence prior to the conference. Subcontractor representatives shall attend.

Discussion shall address project orientation, personnel contact, safety issues, permits, deficiencies, and the location of the Contractor's office.

1.5 PROJECT MEETINGS

The Contractor shall attend weekly project meetings scheduled by the Government. Subcontractor representatives shall attend.

Meeting minutes shall be kept by the GRC Construction Manager and distributed after concurrence by the Contractor.

A Project Submittal Schedule shall be submitted showing full coordination with the project schedule. All products and tests under each submittal number shall be prioritized and linked to the progress schedule.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

A standard transmittal form provided by the Government shall be used to transmit each submittal.

Submittal Description (SD): Drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the work required by the contract.

The following items, SD-01 through SD-11, are descriptions of data to be submitted for the project. The requirements to actually furnish the applicable items will be called out in each specification.

However, as a minimum, provide test reports, installation, operation and maintenance submittals and manuals as original data bound in three ring binders. Equipment actually installed will be clearly marked.

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

SD-02 Shop Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work.

SD-03 Product Data

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

SD-04 Samples

Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

SD-05 Design Data

Design calculations, mix design analyses, or other data, written in nature, and pertaining to a part of the work.

SD-06 Test Reports

Written reports of a manufacturer's findings of his product during field inspections, attesting that the products are installed in accordance with the manufacturer's installation instructions, shop drawings, or other manufacturer's requirements. Written reports by a general contractor or his subcontractors including daily logs reporting on the progress of daily activities or attesting that the work has been installed in accordance with the contract plans and specifications.

SD-07 Certificates

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other Lower Tier Contractor, the purpose of which is to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verification of quality.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any concerning impedances, hazards, and safety precautions.

SD-10 Operation and Maintenance Data

Data intended to be incorporated in an operations and maintenance manual.

1.3 PREPARATION

1.3.1 Marking

Prepare, review and stamp with Contractor's approval all specified submittals.

Permanently mark each submittal to identify it by contract number; transmittal date; Contractor's, Subcontractor's, and supplier's name, address(es) and telephone number(s); submittal name; specification or drawing reference; and similar information to distinguish it from other submittals. Submittal identification shall include space to receive the review action by the Government.

1.3.2 Drawing Format

Drawing submittals shall be prepared on translucent, reproducible sheets,

not less than 8-1/2 by 11 inches nor larger than 30 by 42 inches in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawing reproducibles shall be suitable for microfilming and reproduction on the Diazo or Ozalid machines and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

- a. Job name, which shall be the general title of the contract drawings.
- b. Date of the drawings and revisions.
- c. Name of Contractor.
- d. Name of Subcontractor.
- e. Name of the item, material, or equipment detailed thereon.
- f. Submittal number (e.g., first submittal to last submittal) in a uniform location adjacent to the title block.
- g. Specification section to which submittal applies.
- h. Government contract number shall appear in the margin, immediately below the title block.

Drawings shall be numbered in logical sequence. Contractor may use his own number system. Each drawing shall bear the number of the submittal in a uniform location adjacent to the title block. Government contract number shall appear in the margin, immediately below the title block, for each drawing.

A blank space, no smaller than 75 millimeters by 125 millimeters inches shall be reserved on the right hand side of each sheet for the Government disposition stamp.

1.3.3 Data Format

Required data submittals for each specific material, product, unit of work, or system shall be collected into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical. Partial submittals will not be accepted for expedition of construction effort.

1.3.4 Samples

Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish, pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range (not less than 3 units), shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall

be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

1.4 SUBMISSION REQUIREMENTS

1.4.1 Schedules

Within 15 calendar days of the first notice to proceed provide, for approval by the Construction Manager, the following schedule of submittals:

- a. A schedule of shop drawings and technical submittals required by the specifications and drawings. Indicate the specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the Contractor's anticipated submission date and the approval need date.
- b. A separate schedule of other submittals required under the contract but not listed in the specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approved need date (if approval is required).
- c. Submittals called for by the contract documents will be listed on one of the above schedules. If a submittal is called for but does not pertain to the contract work, the Contractor shall include the submittal in the applicable schedule and annotate it "N/A" with a brief explanation. Approval of the schedules by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the schedules or marked "N/A".
- d. Re-submit copies of both schedules and annotate monthly by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

1.4.2 Drawings Submittals

Submit one translucent reproducible copy and one blackline or blue-line opaque print of each drawing. Six prints, marked with review notations by the Contracting Officer, will be returned to the Contractor. All required installation, fabrication and connection drawings shall be submitted and approved prior to the start of work detailed on these drawings.

1.4.3 Data Submittals

Submit six complete sets of indexed and bound product data. One set, marked with review notations by the Contracting Officer, will be returned to the Contractor.

1.4.4 Samples

Submit one set of identified samples. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to the Contractor.

Samples that are intended or permitted to be returned and actually

incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation.

Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

1.5 GOVERNMENT'S REVIEW

1.5.1 Review Notations

Contracting Officer Technical Representative will review submittals and provide pertinent notation within 21 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

- a. Submittals marked "approved" authorize the Contractor to proceed with the work covered.
- b. Submittals marked "approved as noted" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections. Notes shall be incorporated prior to submission of the final submittal.
- c. Submittals marked "return for correction" require the Contractor to make the necessary corrections and revisions and to re-submit them for approval in the same routine as before, prior to proceeding with any of the work depicted by the submittal.
- d. Submittals marked "not approved" or "disapproved" indicate noncompliance with the contract requirements and shall be re-submitted with appropriate changes. No item of requiring a submittal shall be accomplished until the submittals are approved or approved as noted.
- e. Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes" shall be given to the Contracting Officer. Approval of the submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.
- f. If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved.

1.5.2 Sample Approval

Furnish, for the approval of the Contracting Officer, samples required by the specifications or by the Contracting Officer. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Contracting Officer.

Each sample shall have a label indicating:

- a. Name of project
- b. Name of Contractor
- c. Material or equipment
- d. Place of origin
- e. Name of producer and brand
- f. Specification section to which samples applies
- g. Samples of furnished material shall have additional markings that will identify them under the finished schedules.

Contractor shall submit to the Contracting Officer two samples of materials where samples are requested. Transmit to the Contracting Officer with each sample a letter, original and two copies, containing the above information.

Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Materials and equipment incorporated in the work shall match the approved samples. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. Government reserves the right to disapproved any material or equipment which previously has proved unsatisfactory in service.

Variations from contract requirements shall be specifically pointed out in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor shall replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Contracting Officer shall not relieve the Contractor of his responsibilities under the contract.

1.6 PROGRESS SCHEDULE

1.6.1 Bar Chart

- a. Submit the progress chart, for approval by the Construction Manager, at the Preconstruction Conference in one reproducible and 4 copies.
- b. Prepare the progress chart in the form of a bar chart utilizing form "Construction Progress Chart" or comparable format acceptable to the construction Manager.
- c. Include no less than the following information on the progress chart:
 - (1) Break out by major headings for primary work activity.
 - (2) A line item break out under each major heading sufficient to track the progress of the work.
 - (3) A line item showing contract finalization task which includes punch list, clean-up and demolition, and final construction drawings.
 - (4) A materials bar and a separate labor bar for each line item. Both bars will show the scheduled percentage complete for any given date within the contract performance period. Labor bar will also be shown.
 - (5) The estimated cost and percentage weight of total contract cost for each materials and labor bar on the chart.
 - (6) Separate line items for mobilization and drawing submittal and approval. (These items are to show no associated costs.)
- d. Update the progress schedule in one reproduction and 4 copies every 30 calendar days throughout the contract performance period.

1.7 STATUS REPORT ON MATERIALS ORDERS

Within 20 calendar days after notice to proceed, submit, for approval by the Construction Manager, an initial material status report on all materials orders. This report will be updated once a month.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01411

GENERAL SAFETY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	(1996) Occupational Safety and Health Standards
29 CFR 1926	(1996) Safety and Health Regulations for Construction

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA NPG 8715.3	(2000) NASA Safety Manual
Chapter 9	Glenn Safety Manual

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Records shall be submitted in accordance with paragraph entitled, "Gas Protection," of this section.

SD-07 Certificates

Statements shall be submitted for the following items in accordance with the requirements of this section.

Site-Specific Health and Safety Plan

1.3.1 Site-Specific Health and Safety Plan

Contractor shall submit a site specific health and safety plan (SSHASP) to the Contracting Officer for approval within 10 working days after award of contract and must be approved prior to notice to proceed. Compliance to the SSHASP is expected. A copy of this approved plan shall be maintained

in the Contractor's field office. Each of the on-site workers are required to read, understand, and sign the plan. This document will be made available upon request from the Contracting Officer's Technical Representative and the Glenn Safety Office.

Site-Specific health and Safety plan shall include, as a minimum, the following:

- a. Health and safety program objectives.
- b. Methods to attain health and safety objectives.
- c. Responsibility of key personnel for the Contractor.
- d. Safety meetings, surveys, inspections, and reports.
- e. Identification of unusual health and safety hazards and mitigation plan to allow for safe conduct of work.
- f. Disaster and emergency programs.
- g. Lists of key personnel to be contacted in times of emergency.
- h. Program to show compliance with Federal OSHA Safety and Health Standards 29 CFR 1910 and 29 CFR 1926 and various safety requirements of NASA NPG 8715.3.
- i. Methods to comply with the requirement for immediate reporting of mishaps to the Contracting Officer in accordance with NASA NPG 8621.1A.
- j. Statement that the Contractor will not invalidate the integrity of safety systems without proper authorization.
- j. Procedures for emergency actions to be taken to secure dangerous conditions, to protect personnel, and secure work areas in the event of accident or an act of nature.
1. Procedures for securing the mishap site so that the area remains secure until arrival of a safety investigator. Mishap site will remain secured until released by the Contracting Officer.
1. Provide MSDS sheets for all hazardous materials which will be used. Methods for handling and storage shall be identified.

1.4 GENERAL SAFETY PROVISIONS

The GRC Safety Manual is available online at
http://osat-ext.grc.nasa.gov/gso/manual/chapter_index.shtml

Contractor shall take safety and health measures in performing work under this Contract. Contractor shall meet with the Contracting Officer to develop a mutual understanding relative to administration of the SSHASP. Contractor is subject to applicable federal, state, and local laws, regulations, ordinances, codes, and orders relating to safety and health in effect on the date of this Contract.

During the performance of work under this Contract, the Contractor shall comply with procedures prescribed for control and safety of persons

visiting the project site. Contractor is responsible for his personnel and for familiarizing each of his subcontractors with safety requirements. Contractor shall advise the Contracting Officer of any special safety restriction he has established so that Government personnel can be notified of these restrictions.

1.5 SAFETY LOCKOUT/TAGOUT PROCEDURES

Contractor shall ensure that each employee is familiar with and complies with these procedures and 29 CFR 1910.147.

Contracting Officer will, at the Contractor's request, apply lockout/tagout tags and take other actions that, because of experience and knowledge, are known to be necessary to make the particular equipment safe to work on.

No person, regardless of position or authority, shall operate any switch, valve, or equipment that has an official lockout/tagout tag attached to it, nor shall such tag be removed except as provided in this section.

No person shall work on any equipment that requires a lockout/tagout tag unless he, his immediate supervisor, project leader, or a subordinate has in his possession the stubs of the required lockout/tagout tags.

When work is to be performed on electrical circuits, the work shall be performed only by personnel qualified observing the required safety clearance.

A supervisor who is required to enter an area protected by a lockout/tagout tag will be considered a member of the protected group provided he notifies the holder of the tag stub each time he enters and departs from the protected area.

Identification markings on building light and power distribution circuits shall not be relied on for established safe work conditions.

Before clearance will be given on any equipment other than electrical (generally referred to as mechanical apparatus), the apparatus, valves, or systems shall be secured in a passive condition with the appropriate vents, pins, and locks.

Pressurized or vacuum systems shall be vented to relieve differential pressure completely.

Vent valves shall be tagged open during the course of the work.

Where dangerous gas or fluid systems are involved, or in areas where the environment may be oxygen deficient, system or areas shall be purged, ventilated, or otherwise made safe prior to entry.

1.5.1 Tag Placement and Removal

Lockout/tagout tags shall be completed in accordance with the regulations in Chapter 9 of the Glenn Safety Manual and attached to any device which, if operated, could cause an unsafe condition to exist.

1.6 ACCIDENT TREATMENT AND RECORDS

Contractor shall post emergency first aid and ambulance information at

project site.

Emergency response shall require the Contractor to call 911 on a NASA phone or 216 433-8888 on an outside line or cellular phone.

1.7 FIRE PREVENTION AND PROTECTION

Open-flame heating devices will not be permitted except by approval in writing from the Contracting Officer. Approval for the use of open fires and open-flame heating devices will not relieve the Contractor from the responsibility for any damage incurred because of fires.

Burning trash, brush, or wood on the project site shall not be permitted.

1.8 ELECTRICAL

Contractor shall appoint an individual responsible for the electrical safety of each work team to restrict entry to dangerous locations to those authorized by him jointly with the Government.

1.9 UNDERGROUND UTILITIES

Safety clearance from the Contracting Officer is required before any Contractor personnel enters a manhole. Contractor shall contact the Contracting Officer for support services at least 24 hours in advance.

Prior to removing water and debris from manholes, the Contractor shall contact the NASA Construction Manager or the Contracting Officer for authorization/direction before commencing work.

1.10 FACILITY OCCUPANCY CLOSURE

Streets, walks, and other facilities occupied and used by the Government shall not be closed or obstructed without written permission from the Contracting Officer.

1.11 PROTECTION OF WORK

Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage.

Prior to performing any excavation work or any surface penetrations 6 inches or deeper (such as driving stakes more than 6 inches in the ground) on any ground surface, the Contractor shall obtain from the inspection office the current subsurface utility drawing of the particular area to be worked on. Contractor shall stake out subsurface high voltage cables, communication cables, and pipe lines indicated within the scope of the work contemplated.

After exposure, the Contractor shall obtain agreement from the Contracting Officer on how much closer to cable or pipe the excavations can be permitted.

Contractor shall notify the Contracting Officer, 48 hours prior to the start of excavation work or surface penetration, to enable the Contracting Officer to review measures being taken to prevent hazard to employees and possible damage to subsurface utilities. Where emergency conditions preclude the 48 hours advance notification, the Contractor shall immediately inform the Contracting Officer of his intention to initiate work prior to actual start of activity.

After obtaining clearance from the Contracting Officer, the Contractor shall proceed with excavating work, or other surface penetration work. Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 10 feet of the staked-out cable or pipe line until the Contractor has exposed the cable or pipe by hand excavation to fix its location.

1.12 GAS PROTECTION

Contractor shall have one or more employees properly trained in operation of gas testing equipment and formally qualified as gas inspectors who shall be on duty during times workmen are in confined spaces. Their primary functions shall be to test for gas and operate testing equipment. Unless equipment of constant supervisory type with automatic alarm is employed, gas tests shall be made at least every 2 hours or more often when character of ground or experience indicates gas may be encountered. A gas test shall be made before workmen are permitted to enter the excavation after an idle period exceeding one-half hour.

Readings shall be permanently recorded daily, indicating the concentration of gas, number and location of drilled piers, point of test, date, and time of test.

Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical character, may be oxygen deficient. A check by Government is required prior to entering confined space. Surveillance and monitoring shall be required in these types of work spaces by both Contractor and Government personnel.

1.13 ROOFING AND COATING

At the beginning of each work day the Contractor shall check with the Contracting Officer before proceeding to work on the roof to ensure safe work conditions.

1.14 WELDING, FLAME CUTTING, AND MELTING

Contractor shall clear welding and cutting operations with the Contracting Officer before operations begin. See Glenn Safety Manual, Chapter 28, "Hot Work Authorization".

Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour after discontinuing these operations to make thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound carbon dioxide fire extinguishers. Any unsafe conditions shall be reported to the Glenn Safety Office.
(Telephone: (216) 433-2088)

During operations involving possible fire hazard, the Contractor shall notify the Contracting Officer and not proceed until clearance is obtained in writing. Contracting Officer may request a standby from the Glenn Safety Office. This requirement does not relieve the Contractor of his responsibility for welding and cutting safety.

1.15 HIGH NOISE LEVEL PROTECTION

Operations performed by the Contractor that involve the use of equipment

with output of high noise levels (jackhammers, air compressors, and explosive device activated tools) shall be scheduled with the Construction Manager or Contracting officer and shall be approved, in writing, prior to commencement of work.

1.16 SEVERE STORM PLAN

In the event of a severe storm warning, the Contractor shall:

- a. Secure outside equipment and materials and place materials possible to damage in protected locations.
- b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.
- c. Ensure that temporary erosion controls are adequate.

1.17 HAZARDOUS WASTE

Contractor shall identify all wastes produced and dispose of them in the following approved manners:

Identify all wastes and waste producing processes including chemicals, paints, POL products and solvents, and their containers. Unknown wastes will be chemically identified by the Government.

Obtain a determination of whether the waste is hazardous from the Contracting Officer.

Notify the Contracting Officer and obtain approval prior to taking disposal action for any hazardous waste.

For disposal, provide either laboratory analysis data documenting the chemical content of the waste or certification by appropriate organization authority as to the chemical constituents of the waste. Technical assistance on disposal analysis requirements will be provided on request by contacting the Contracting Officer.

Document the waste type, quantity, location, and personnel/contractor/agency responsible so the material can be tracked from generation through ultimate disposal as required by Environmental Protection Agency under Resource Conservation and Recovery Act.

1.18 CONFINED SPACE

Comply with the requirements in Chapter 16 of the Glenn Safety Manual, 29 CFR 1910.146 and NHS/IHS 1845.2. Any potential for a hazard in the confined space requires a permit system to be used. NHS/IHS 1845.2 is available on the internet at

- a. Entry Procedures. Prohibit entry into a confined space by personnel for any purpose, including hot work, until the qualified person has conducted appropriate tests to ensure the confined or enclosed space is safe for the work intended and that all potential hazards are controlled or eliminated and documented. All hazards pertaining to the space, and control methods, shall be reviewed with each employee during review of the AHA.

- b. Forced air ventilation is required for all confined space entry operations and the minimum air exchange requirements must be maintained.
- c. Ensure the use of rescue and retrieval devices in confined spaces greater than 5 feet in depth.
- d. Manholes and excavations require continuous atmosphere monitoring with audible alarm for toxic gas detection and low oxygen levels.
- e. Include training information for employees who will be involved as entrant attendants for the work.
- f. Entry Permit. NASA form C-199, shall be completed by the qualified person. Following approval by NASA, post the permit in a conspicuous place close to the confined space entrance.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Reference publications are cited in other sections of the specifications along with identification of their sponsoring organizations. The addresses of the sponsoring organizations are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

ALUMINUM ASSOCIATION (AA)

900 19th Street N.W.
Washington, DC 20006
Ph: 202-862-5700
Fax: 202-862-5164
Internet: www.aluminum.org

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

444 N. Capital St., NW, Suite 249
Washington, DC 20001
Ph: 800-231-3475 or 202-624-5800
Fax: 800-525-5562 or 202-624-5806
Internet: www.aashto.org

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001
Ph: 312-670-2400
Publications: 800-644-2400
Fax: 312-670-2400
Internet: <http://www.aiscweb.com>

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

11 West 42nd St
New York, NY 10036
Ph: 212-642-4900
Fax: 212-302-1286
Internet: <http://www.ansi.org/>

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

1791 Tullie Cir., NE
Atlanta, GA 30329-2305
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
Internet: <http://www.ashrae.org>

AMERICAN WELDING SOCIETY (AWS)

550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353
Fax: 305-443-7559
Internet: www.amweld.org

ASME INTERNATIONAL (ASME)

Three Park Avenue
New York, NY 10016-5990
Ph: 212-591-7722
Fax: 212-591-7674
Internet: www.asme.org

ASSOCIATED AIR BALANCE COUNCIL (AABC)

1518 K St., NW, Suite 503
Washington, DC 20005
Ph: 202-737-0202
Fax: 202-638-4833

ASTM INTERNATIONAL (ASTM)

100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
Internet: www.astm.org

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

355 Lexington Ave.
New York, NY 10017-6603
Ph: 212-297-2100
Fax: 212-370-9047
Internet: www.buildershardware.com

DOOR AND HARDWARE INSTITUTE (DHI)

14170 Newbrook Dr.
Chantilly, VA 20151-2232
Ph: 703-222-2010
Fax: 703-222-2410
Internet: www.dhi.org
E-mail: techdept@dhi.org

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

2500 Wilson Blvd.
Arlington, VA 22201-3834
Ph: 703-907-7500
Fax: 703-907-7501
Internet: www.eia.org

FM GLOBAL (FM)

1301 Atwood Avenue

P.O. Box 7500
Johnston, RI 02919
Ph: (for publications) 781-255-6681
Ph: (Toll-Free): 877-364-6726
Fax: 781-255-0181
Internet: <http://www.fmglobal.com>

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
Ph: 732-981-0060 OR 800-701-4333
Fax: 732-981-9667
Internet: <http://www.standards.ieee.org>
E-mail: customer.service@ieee.org

INTERNATIONAL CODE COUNCIL (ICC)

5203 Leesburg Pike, Suite 708
Falls Church, VA 22041
Ph: 703-931-4533
Fax: 703-379-1546

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

127 Park St., NE
Vienna, VA 22180-4602
Ph: 703-281-6613
Fax: 703-281-6671
Internet: [//cssinfo.com/info/mss/html](http://cssinfo.com/info/mss/html)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Publication(s) Available From
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
Ph: 202-783-3238

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1300 N. 17th St., Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 202-841-3300
Internet: <http://www.nema.org/>

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

8575 Grovemont Circle
Gaithersburg, MD 20877-4121
Ph: 301-977-3698
Fax: 301-977-9589

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

One Batterymarch Park
P.O. Box 9101

Quincy, MA 02269-9101
Ph: 800-344-3555
Fax: 800-593-6372
Internet: <http://www.nfpa.org>

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

4201 Lafayette Center Drive
Chantilly, VA 20151-1209
Ph: 703-803-2980
Fax: 703-803-3732
Internet: <http://www.smacna.org>

STEEL DOOR INSTITUTE (SDI)

30200 Detroit Rd.
Cleveland, OH 44145-1967
Ph: 216-899-0010
Fax: 216-892-1404

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656
Ph: 412-281-2331
Fax: 412-281-9992
Internet: www.sspc.org

UNDERWRITERS LABORATORIES (UL)

333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 847-272-8800
Fax: 847-272-8129
Internet: <http://www.ul.com/>
Order from:
Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5776
Ph: 800-569-7128
Fax: 303-397-7945
Internet: <http://global.ihs.com>
E-mail: global@ihs.com

U.S. DEPARTMENT OF DEFENSE (DOD)

Order DOD Documents from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Ph: 703-605-6000
FAX: 703-605-6900
Internet: <http://www.ntis.gov>
Order Military Specifications, Standards and Related Publications
from:

Department of Defense Single Stock Point for (DODSSP)
Defense Automation and Production Service (DAPS)

Bldg 4D
700 Robbins AV
Philadelphia, PA 19111-5094
Ph: 215-697-2179
Fax: 215-697-1462
Internet: <http://www.dodssp.daps.mil>

U.S. DEPARTMENT OF ENERGY (DOE)

Order from:
1000 Independence Avenue Southwest
Washington, D.C. 20585
Ph: 800-363-3732
Internet: <http://www.eren.doe.gov/femp/procurement>

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

General Services Administration
1800 F Street, NW
Washington, DC 20405
PH: 202-501-0705
Order from:
General Services Administration
Federal Supply Service Bureau
1941 Jefferson Davis Highway
Arlington, VA 22202
PH: 703-605-5400
Internet: <http://www.fss.gsa.gov/pub/fed-specs.cfm>

WINDOWS AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

1400 East Touhy Ave., Suite G-54
Des Plaines, IL 60018
Ph: 847-299-5200 or 800-223-2301
Fax: 708-299-1286

-- End of Section --

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component of, each section of the specifications.

1.2 SUBMITTALS (Not Applicable)

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

Contractor shall provide temporary utilities required for construction. Materials may be new or used, shall be adequate for the required usage, shall not create unsafe conditions, and shall not violate applicable codes and standards.

3.1.1 Electricity

Contractor shall provide connections, sized to provide service required for power and lighting. Feeder and branch wiring with area distribution boxes shall be located so that power is available throughout the project site by use of power cords. 120/240 electrical volt feeder service is available. Lighting shall be provided by the Contractor. Electricity used will be furnished by the Government.

3.1.2 Water

Contractor shall make connections to existing facilities to provide water for construction purposes. Water used will be furnished by the Government.

3.1.3 Telephone Service

Contractor shall provide telephone service. Contractor shall pay costs of service.

3.1.4 Sanitary Facilities

Contractor may use existing sanitary facilities during the construction period.

3.1.5 Fire Protection

Contractor shall provide temporary fire protection equipment for the protection of personnel and property during construction. Debris and flammable materials shall be removed daily to minimize potential hazards.

3.2 SIGNS

3.2.1 Construction Sign

Within 30 days after notice to proceed, the Contractor shall install the construction identification sign at the location designated by the Contracting Officer.

3.2.2 Other Signs and Advertisements

Only signs necessary to expedite deliveries, maintain traffic flow, promote safety (e.g. caution, danger, blasting, hardhat area), and prevent interference with Government operations shall be erected.

3.3 TRAFFIC PROVISIONS

3.3.1 Maintenance of Traffic

Contractor shall conduct his operations in a manner that will not close any thoroughfare or interfere in any way with traffic on railways or highways except with written permission of the Contracting Officer. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

Work shall be conducted so as to minimize obstruction of traffic, and traffic shall be maintained on at least half of the roadway width at all times. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic.

Contractor shall provide, erect, and maintain, at his own expense, lights, barriers, signals, passageways, detours, etc., that may be required.

3.3.2 Rush Hour Restrictions

Contractor shall not interfere with the peak traffic flows preceding and during normal operations without notification to and approval by the Contracting Officer.

3.3.3 Dust Control

Contractor's dust control methods and procedures shall be approved by the Contracting Officer. Dust abatement on access roads shall be treated with applications of calcium chloride, water sprinklers, or similar methods or treatment.

3.4 PROTECTION OF EXISTING SYSTEMS

3.4.1 Utility

Connection to existing utilities, identified on the drawings to the Contractor, shall be protected from damage during construction activity.

3.4.2 Safety

Contractor shall protect the integrity of any installed safety systems or personnel safety devices.

If entrance into systems serving safety devices is required, the Contractor shall obtain prior approval from the Contracting Officer. If it is

temporarily necessary to remove or disable personnel safety devices in order to accomplish contract requirements, the Contractor shall provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and shall obtain prior approval from the Contracting Officer.

-- End of Section --

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

Not Used

1.3 SHIPMENT AND PROTECTION OF MATERIAL AND EQUIPMENT

Shipments shall be addressed to the Contractor who shall be responsible for their receipt, unloading, handling, and storage at the site. Government will not accept deliveries on behalf of the Contractor or his subcontractors or assume responsibility for security of materials, equipment, or supplies delivered to the site.

Contractor shall protect and preserve materials, supplies, and equipment of every description, (including property which may be Government-furnished or -owned) and work performed.

1.4 STORAGE AND PROTECTION OF MATERIAL

1.4.1 Salvage Material

Material to be salvaged and reinstalled by the Contractor shall be protected during removal and stored to prevent damage.

1.4.2 New Material and Construction Equipment

Only material and construction equipment designated for performance of contract work may be stored at the construction site or located in Government-controlled warehouses or shop facilities.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Material and equipment shall be installed in accordance with the requirements of the contract drawings, contract specifications and referenced standards and specifications.

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01750

STARTING AND ADJUSTING

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-06 Test Reports

Test reports shall be submitted in accordance with the paragraphs entitled, "Factory Tests", "Functional Test" and "Final Acceptance Test," of this section.

Test procedures and the recording forms shall be submitted according to paragraph entitled, "Test Procedures."

1.2.1 Tests Required

Tests shall be performed to verify proper functioning of fire protection, fire suppression, HVAC, compressed air, electrical switchgear, protective relaying, fluid and gas systems, pump/motor combinations, hydraulic and pneumatic control, condition/performance monitoring systems, energy control and monitoring systems, and other assemblies and components that need to be tested as an interrelated whole.

1.2.2 Factory Tests

Tests shall be performed at the factory to verify proper build. These test results will be used in the "Final Acceptance Test" section to verify no shipping damage and proper installation.

1.2.3 Functional Test

Contractor shall perform an "in-house" test to verify that the system and components have been properly installed and are functioning properly. Test shall be performed in the presence of the Contracting Officer Technical Representative. Test shall be completed and found acceptable when system has performed as designed.

1.2.4 Final Acceptance Test

Contractor shall perform a formal test with full documentation using the approved recording form. Contracting Officer Technical Representative will witness this test and issue a written final acceptance. Final test data shall be provided to the Contracting Officer Technical Representative. Data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems

Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

1.2.5 Test Procedures

Test procedure and recording forms that document the test steps shall be submitted for approval to the Contracting Officer 21 calendar days prior to the proposed test date. Procedure shall consist of step by step instruction to verify system parameters, components, and functions.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Reproducible Drawings
CAD System Drawings

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-03 Product Data

Spare Parts Data shall indicate manufacturer's name, part number, nomenclature, and stock level recommended for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

SD-07 Certificates

A Work Plan shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-08 Manufacturer's Instructions

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Preventative Maintenance and Condition Monitoring (Predictive Testing) and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Schedule shall define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements. Each test feature; e.g., gpm, rpm, psi,

shall have a signoff blank for the Contractor and Contracting Officer. A remarks column of the testing validation procedure shall include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Procedures for preventative maintenance, condition monitoring (predictive testing) and inspection, adjustment, lubrication and cleaning necessary to prevent failure shall be delineated.

Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section. Equipment data sheets will be included for each piece of equipment purchased and/or installed.

1.4 GENERAL

As-Built Drawings shall be submitted under the following criteria:

In order to minimize the time for final payment at the completion of the project, the Contractor shall update the as-built drawings every month with the Contracting Officer's authorized representative. This update will be a part of "the monthly request for payment meeting," and payment--or a portion of the payment, including final payment--may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

After completion of all construction and before final payment is made under this contract, the Contractor shall provide the Contracting Officer with one complete set of full size blue line contract drawings with alterations shown in red pencil.

Preventative Maintenance and Condition Monitoring (Predictive Testing) and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Repair requirements shall inform operators how to check out, troubleshoot, repair, and replace components of the system. Instructions shall include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

A Work Plan shall be submitted to the Contracting Officer for project closeout. Plan shall include all scheduled inspections, instruction classes, items, closeout dates for all functions, and shall list the required Government and Contractor personnel that will be taking part in these functions.

Posted Instructions shall be submitted by the Contractor with labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

Contractor shall submit 6 copies of the project operation and maintenance manuals 30 days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 days prior to

contract completion.

Spare Parts Data shall indicate manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Information shall be bound in manual format and grouped by technical sections. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 10 millimeter holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. Binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

Contractor shall submit classroom and field instructions in the operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory-trained personnel or qualified representatives. Contracting Officer shall be given 7 days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor, such as lists, static exhibits, and visual aids, shall be made available to the Contracting Officer.

-- End of Section --

SECTION 04225

CONCRETE MASONRY UNITS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615/A 615M	(1995; Rev A) Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 82	(1994) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C 144	(1993) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 207	(1991; R 1992) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 270	(1991) Standard Specification for Mortar for Unit Masonry
ASTM C 404	(1994) Standard Specification for Aggregates for Masonry Grouts
ASTM C 476	(1991) Standard Specification for Grout Masonry
ASTM C 90	(1995) Standard Specification for Load-Bearing Concrete Masonry Units

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with reference standards contained within this section.

Concrete Masonry Units
Mortar

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

Concrete masonry units shall include all special shapes and sizes required to complete the work. Concrete masonry units shall conform to ASTM C 90, Type I, Grade N, normal weight.

2.2 MORTAR

Mortar shall be mixed in proportions as specified in ASTM C 270.

2.3 GROUT

Grout shall conform to ASTM C 476. Compressive strength at 28 days shall be minimum.

2.4 PORTLAND CEMENT

Portland cement shall conform to ASTM C 150, Type II.

2.5 AGGREGATE

Sand for mortar shall conform to ASTM C 144. Pea Gravel for grout shall conform to ASTM C 404.

2.6 LIME

Hydrated lime shall conform to ASTM C 207, Type S.

2.7 WATER

Water shall be potable.

2.8 REINFORCEMENT

2.8.1 Joint Reinforcement

Joint reinforcement shall be fabricated from steel wire conforming to ASTM A 82. Longitudinal wires shall be not lighter than 0.1483-inch nominal diameter. Cross wires shall be not lighter than 0.1055-inch nominal diameter. Joint reinforcement shall be furnished in flat sections.

2.8.2 Reinforcing Steel Bars

Reinforcing steel bars shall conform to ASTM A 615/A 615M, Grade 60, deformed, free of loose rust and scale.

2.9 MASONRY PARGING

Provide SikaRepair 223+ SikaLatex R, two component, early strength gaining, polymer modified cementitious non-sag material as manufactured by Sika or approved equal.

Parge walls where indicated to cover coat work. See Elevation A and B on drawing CF 176647. Wall shall be parged from window sill down to finish floor on both elevations.

PART 3 EXECUTION

3.1 MORTAR

Mortar shall be thoroughly machine mixed for a period of 3 to 5 minutes after all materials are in a mixer designed for this purpose.

Mortar shall be used and placed in final position within 1-1/2 hours after mixing when air temperature is less than 80 degrees F. No mortar shall be placed when air temperature is 40 degrees F and falling.

Mortars that have stiffened within the allowable time may not be retempered to restore workability by adding water as frequently as needed.

3.2 LAYING CONCRETE BLOCK

Block shall be laid dry and cut accurately to fit other construction. All cutting of units shall be done with power saws with abrasive blades.

Block work shall be laid plumb, level, and true to line and grade.

Running bond pattern shall be used.

Mortar joints shall be 3/8-inch thick. Full mortar coverage of bed joints shall be provided at shells.

3.3 GROUT

Grout shall be thoroughly machine mixed for a period of at least 5 minutes after all materials are in a mixer designed for this purpose.

Cells shall be grouted solid in maximum 4-foot lifts. The pour shall be stopped 1-1/2 inches below the top of the block. A cleanout shall be provided at the bottom of cells where the pour of grout is in excess of 4 feet. Continuous unobstructed cell area of not less than 2 by 3 inches shall be maintained. Anchors, bolts, inserts, etc., shall be solidly grouted in place. Where required, filling of cells that are to remain open shall be prevented by means of a metal lath or a shield and by mortaring cross-webs where adjacent cells or cavities are to be grouted.

Grouting shall be performed in one continuous operation.

3.4 JOINTING AND POINTING EXPOSED MASONRY

Joints shall be pointed and tooled before mortar is set and brushed with a fiber brush after tooling. Interior joints shall have flush packed joints.

3.5 EMBEDDED ITEMS

Embedded items shall be set in accordance with the construction drawings. Anchors shall be surrounded by grout.

3.6 METAL DOOR JAMBS

Metal door jambs in masonry walls shall have frames filled solidly with mortar as the work progresses.

3.7 CURING, PROTECTION, AND CLEANING

Curing by saturation with water will not be permitted. Exposed exterior surfaces shall be protected from sun and heat with light fog spray for a period of 3 days.

Exposed masonry surfaces shall be protected from mortar droppings. Sills, ledges, and projecting courses shall be covered with water-repellent covering.

Grout or mortar stains shall be cleaned by removing immediately with clear water, stiff fiber brushes, or wooden scrapers, and rinsed before final acceptance.

3.8 PARING

Remove all deteriorated concrete, dirt, and all bond-inhibiting materials from surface of concrete block.

Mix and apply in accordance with manufacturer's written instructions.

-- End of Section --

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2000) Code of Standard Practice for Buildings and Bridges
AISC 316	(1989; 9th Ed) Manual of Steel Construction, Allowable Stress Design
AISC 317	(1992) Manual of Steel Construction, Volume II, Connections
AISC 326	(2002) Detailing for Steel Construction
AISC M014	(1984; 1st Ed) Engineering for Steel Construction a Source Book on Connections

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.22.1	(1975; R 1998) Plain Washers
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AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1998) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2004) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2004) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 242/A 242M	(2003a) High-Strength Low-Alloy Structural Steel
ASTM A 307	(2003) Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	(2004) Standard Specification for Structural Bolts, Steel, Heat Treated,

120/105 ksi Minimum Tensile Strength

ASTM A 36/A 36M	(2003a) Standard Specification for Carbon Structural Steel
ASTM A 500	(2003a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 514/A 514M	(2000a) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding
ASTM A 53/A 53M	(2002) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM D 2939	(2003) Emulsified Bitumens Used as Protective Coatings
ASTM E 164	(2003) Ultrasonic Contact Examination of Weldments
ASTM E 165	(2002) Standard Test Method for Liquid Penetrant Examination
ASTM E 709	(2001) Standard Guide for Magnetic Particle Examination

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 25	(1997) Paint Specification No. 25, Red Iron Oxide, Zinc Chromate, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 10	(2000) Joint Surface Preparation, Standard Near-White Metal Blast Cleaning (NACE No. 2)

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings for the following items shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

Structural Steel

SD-07 Certificates

Welding Procedures and certificates for Welder Qualifications shall be submitted in accordance with paragraph entitled, "Qualifications for Welding Work," of this section.

1.3 QUALIFICATIONS FOR STRUCTURAL STEEL WORK

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude.

1.4 QUALIFICATIONS FOR WELDING WORK

Welding Procedures shall be in accordance with AWS D1.1/D1.1M.

Certificates for Welder Qualifications shall include the type of welding and positions each operator is qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

1.5 FABRICATION REQUIREMENTS

AISC 316 and AISC 303 shall govern all work.

Design of members and connections for any portion of the structure not indicated shall be completed by the fabricator and indicated on detail drawings.

Substitution of sections or modification of details, or both, and the reasons for the action shall be submitted with the detail drawings for approval.

Structural steel shall be fabricated and assembled in the shop to the greatest extent possible. Parts not assembled in the shop shall be secured by bolts for shipment.

Shop splices of members between field splices will be permitted only where indicated. Splices not indicated must be approved. Field splices in compound joints will not be permitted.

1.5.1 Tolerances

Tolerances in fabrication and erection shall be in accordance with AISC 303.

1.5.2 Connections

One-sided or other types of eccentric connections will not be permitted, unless indicated in detail and approved.

Shop connections shall be welded.

Field connections shall be bolted, except where welded connections are indicated, as follows:

High-strength threaded fasteners shall be used for bolted connections, except where otherwise specified.

Low carbon steel threaded fasteners may be used only for bolted connections of secondary members to primary members (such as, purlins, girts, and other framing members carrying only nominal stresses) and for temporary bracing to facilitate erection.

High-strength bolting shall conform to AISC 317 and shall be friction-type connections as modified by the bonding and grounding requirements.

Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operation shall be removed with a tool making a 1/16-inch bevel.

Bolts shall be inserted into holes without damaging thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing to the head or nut.

Low carbon steel threaded fasteners shall be of length that will extend through, but not more than 1/4 inch beyond, the nuts. Bolt heads and nuts shall be drawn tight against the work with a suitable wrench not less than 15 inches long. Bolt heads shall be tapped with a hammer while the nut is being tightened. Nuts shall be locked after tightening. Where self-locking nuts are not furnished, bolt threads shall be upset.

1.6 BONDING AND GROUNDING

Where indicated, bonding of joints and connections shall be accomplished as specified in Section 16065, "Secondary Grounding." In friction-type joints, faying surfaces shall be clean and abrasive-blasted to near-white metal. Faying surfaces shall be coated to avoid crevice corrosion.

1.7 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2-inch and location shall be shown on the detail drawings. Hole size and location shall not affect structural integrity.

1.8 DRAWINGS

Fabrication Drawings for Structural Steel and Accessoriesshall be in accordance with AISC 316, AISC 326 and AISC M014. Drawings shall show standard welding symbols in accordance with AWS A2.4.

Installation Drawings for structural steel units shall indicate the members and connection areas not to be painted, sequence of erection, and detailed sequence of welding including each welding procedure. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and provided for record purposes.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36/A 36M.

2.1.2 High-Strength Low-Alloy Steel

High-strength low-alloy steel shall conform to ASTM A 242/A 242M.

2.1.3 High-Strength Alloy Steel Plate

High-strength alloy steel plate shall conform to ASTM A 514/A 514M.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade B.

2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53/A 53M, Type E, Grade B.

2.4 LOW-CARBON STEEL THREADED FASTENERS

Bolts and Nuts shall conform to ASTM A 307, Grade A galvanized according to ASTM A 153/A 153M.

Round washers shall be plain, conforming to ANSI B18.22.1, Type B, galvanized according to ASTM A 153/A 153M.

2.5 HIGH-STRENGTH THREADED FASTENERS

High-strength Washers, Bolts and Nuts shall conform to ASTM A 325. Galvanize according to ASTM A 153/A 153M.

2.6 WELDING MATERIALS

Welding materials, to include Welding Electrodes and Rods, shall conform to AWS D1.1/D1.1M.

2.7 PROTECTIVE COATING

Unless otherwise noted, steelwork shall be shop primed with red oxide Primer in accordance with SSPC Paint 25 except surfaces of steel to be encased in concrete, surfaces to be welded, and contact surfaces to be high-strength bolt connected.

Steelwork indicated to be galvanized shall be hot dipped galvanized in accordance with ASTM A 123/A 123M. Abraded surfaces and cut ends of galvanized members shall be touched up with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

Steelwork embedded in concrete shall be coated with a bituminous mastic conforming to ASTM D 2939.

PART 3 EXECUTION

3.1 GENERAL

Erection of structural steel shall be in accordance with the AISC 303, with modifications and additional requirements as specified.

3.2 ERECTING EQUIPMENT

Equipment shall be suitable and safe for workers. Falsework shall be maintained in a safe and stable condition until the steel structure is fully self-supporting.

3.3 ANCHOR BOLTS

Bolts and other connections between structural steel and foundations or existing structural steel shall be performed as part of the work.

Bolts and anchors shall be accurately located and built into connecting work and shall be preset by the use of templates or other methods as may be required to locate bolts and other connections.

3.4 FIELD ASSEMBLY

Structural steel frames shall be assembled to lines and elevations indicated. Various members forming parts of a completed frame or structure after being assembled shall be aligned and adjusted before being fastened. Fastening of splices of compression members shall be done after abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before members are assembled.

Splices will be permitted only where indicated. Erection bolts used in welded construction shall be removed and the holes shall be filled with plug welds.

Bracing, adequacy of temporary connections and supports, alignment, and removal of paint on surfaces adjacent to field welds shall be as specified in AISC 303.

Welding for re-drilling will not be permitted. Holes shall not be enlarged more than 1/16-inch larger than the specified hole size without approval of the Contracting Officer.

3.5 GAS CUTTING

Use of a gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.6 TOUCHUP PAINTING

After erection of structural steel, the Contractor shall touch up bolt heads and nuts, field welds, and abrasions in the shop coat. Touchup and repair shall be accomplished as soon as possible after the damage or installation has occurred.

Surfaces shall be degreased, as required, prior to subsequent surface preparation. Degreasing shall be accomplished by steam cleaning or washing with a solution of trisodium phosphate in water, followed by a fresh water rinse. Cuts, welds, and large damaged areas shall be cleaned to near white SSPC SP 10. Mechanical cleaning by needle gun or abrasive disks or wheels shall be used. Minor abrasions and scars where extensive rusting has not occurred shall be rendered clean and dry and touched up without further surface preparation. Repair coating shall be applied within 6 hours after surface preparation or before rusting or re-contamination occurs. Touchup and repair material shall be the same inorganic zinc coating as applied in the shop. Application shall be by airless or conventional spray. Compressed air used for coating application shall be free of moisture and oil. Manufacturer's recommended procedures shall be followed.

3.7 INSPECTION AND ACCEPTANCE PROVISIONS

3.7.1 Inspection and Tests

Inspection by the Contractor shall include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of wrenches for high-strength bolts.

3.7.2 Inspection of Welding

Inspection of welding shall be performed in accordance with AWS D1.1/D1.1M, Section 6, "Inspection," and as follows:

Liquid penetrant inspection of the welds shall conform to ASTM E 165.

Magnetic particle inspection of the welds shall conform to ASTM E 709.

Radiographic inspection of the welds shall conform to AWS D1.1/D1.1M, Section 6, Part B.

Ultrasonic inspection of the welds shall conform to ASTM E 164.

3.7.3 Inspection of High-Strength Bolted Connections

Inspection of high-strength bolted connections shall be performed in accordance with AISC 317.

-- End of Section --

SECTION 07210

BUILDING INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM C 665	(2000e1) Standard Specification for Mineral Fiber-Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM D 5359	(1998; R 2004) Standard Specification for Glass Cullet Recovered from Waste for use in Manufacture of Glass Fiber

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's product data shall be submitted for the following items:

Batts and Rolls

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered to the project site in their original, unopened packages or containers bearing labels identifying the manufacturer's name, brand name, material, and other information.

Materials shall be stored in their original unbroken packages or containers in a weathertight and dry area, and protected from damage until ready for use.

PART 2 PRODUCTS

2.1 THERMAL-INSULATION MATERIALS

2.1.1 Glass-Fiber Insulation

For informational purposes, a list of known sources for recycled building insulation is provided below. Note that the Contractor is not limited to these sources. An approved product from other sources may be submitted for the Government's approval during construction.

Acceptable manufacturer's include, but are not limited to:

Certain Teed Corporation
Guardian Fiberglass, Inc.
Johns Manville Corp.
Owens-Corning Fiberglass Corporation
Western Fiberglass, Inc.

2.1.1.1 Batts and Rolls

Glass-fiber insulation batts and rolls shall be of nominal thickness and width indicated with an R-13. Insulation shall conform to ASTM C 665 for the following:

Type I, unfaced insulation

Glass-fiber insulation batts and rolls shall contain a total recovered materials content of 20-25 percent recovered glass cullet. Glass cullet shall conform to ASTM D 5359.

2.2 FASTENING MATERIALS

2.2.1 Adhesive

Adhesive shall have a bonding strength of 70 pounds per clip after a 3-day drying time at 70 degrees F and shall have a temperature range of minus 20 degrees to plus 225 degrees F.

PART 3 EXECUTION

3.1 GENERAL

Building insulation shall be installed in accordance with approved descriptive data and as specified.

Insulation material shall be cut and fit as necessary to fully insulate small areas between closely spaced framing members and to accommodate piping, conduit, outlet boxes, and other construction penetrating the insulation material.

3.2 PREPARATION OF SURFACES

Surfaces on which thermal-insulation materials are to be applied shall be clean, smooth, dry, and free from projections that might puncture the vapor barriers. Condition of surfaces shall be inspected and approved prior to the start of building insulation work.

Construction shall be supplemented with nailers, furring strips, or other supporting members to support the insulation in its proper location.

3.3 WALL AND CEILING INSULATION SYSTEM

Glass-fiber insulation batts and rolls shall be placed between wall and ceiling framing members, fitting snugly against framing members. Insulation shall be cut to required length for each space to be insulated.

Batts without membrane facing shall be secured in place between framing members by means of wood nailing strips or an approved adhesive, standard

with the insulation materials manufacturer.

3.4 WALL AND CEILING INSULATION SYSTEM: METAL STUD

Insulation shall be wired or taped to metal studs as recommended by the metal-stud manufacturer.

3.5 INSPECTION AND ACCEPTANCE PROVISIONS

3.5.1 Finished-Building Insulation Requirements

Building insulation work will be rejected for, but not limited to, any of the following deficiencies:

Thermal insulation material not conforming to the type and nominal thickness indicated for the kind of construction

Insulated construction not having small areas between closely spaced framing members fully insulated

Installed thermal-insulation material damaged or wetted by exposure to inclement weather

3.5.2 Repair of Defective Work

Defective work shall be removed and replaced, at no expense to the Government, with building insulation materials that meet the requirements of this section.

-- End of Section --

SECTION 07920

SEALANTS AND CALKINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM C 834 (2000e1) Latex Sealants

ASTM C 920 (2002) Standard Specification for
Elastomeric Joint Sealants

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Flexible Cellular Backing
Bond-Preventative Material
Primer
Oil and Resin-Based Sealants
Elastomeric Sealants
Latex Sealants
Solvents and Cleaning Agents

SD-04 Samples

The Contractor shall submit the following samples:

Three cured color bead samples of each color and type of Sealing Compound to be used in the work, approximately 1/4-inch wide by 1-inch long.

Three Labels for each sample container of sealants including the following information; supplier, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, life expectancy of the application, curing time, and shelf life.

Three Backup Material samples of each material, grade, rod size, and tube size to be used in the work, full size by 12-inches long.

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with referenced standards contained in this section.

Flexible Cellular Backing
Bond-Preventative Material
Primer
Solvents and Cleaning Agents

SD-08 Manufacturer's Instructions

Manufacturer's Installation instructions shall be submitted for the following in accordance with paragraph entitled, "Sealants," of this section.

Thermoplastic Sealing Compound
Two-Component Elastomeric Sealant

1.2.1 Samples

Provide three cured color bead samples of each color and type of Sealing Compound to be used in the work, approximately 1/4-inch wide by 1-inch long.

Three Labels for each sample container of sealants shall include the following information; supplier, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, life expectancy of the application, curing time, and shelf life.

Three Backup Material samples of each material, grade, rod size, and tube size to be used in the work, full size by 12-inches long.

1.3 QUALITY ASSURANCE

1.3.1 Compatibility with Substrate

Sealants shall be verified for compatibility for use with joint substrates.

1.3.2 Joint Tolerance

Joint tolerances shall be in accordance with manufacturer's instructions.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered in sealed containers that identify the product, manufacturer, color, directions for use, shelf life, and curing time.

Materials shall be kept dry and shall be protected from freezing.

1.5 SPECIAL WARRANTY

Sealant joint shall be guaranteed against failure of sealant and against water penetration through each sealed joint for five years.

PART 2 PRODUCTS

2.1 BACKUP MATERIAL

2.1.1 Flexible Cellular Backing

2.1.2 Polyethylene

Polyethylene material shall be closed cell polyethylene as recommended by the sealant manufacturer.

2.2 BOND-PREVENTATIVE MATERIAL FOR SEALING COMPOUNDS

Bond-preventive material shall be pressure sensitive tape, as recommended by the sealant manufacturer to suit application.

2.3 PRIMER-TO-SEALANT COMPOUNDS

Primer shall be non-staining type as recommended by sealant manufacturer to suit application.

2.4 SEALANTS

Manufacturer's Installation instructions shall be submitted for Thermoplastic Sealing Compound and Two-Component Elastomeric Sealant covering procedures, suggested mixing equipment, storage requirements, and procedures for surface preparation.

2.4.1 Elastomeric

Elastomeric Sealants shall be single component, color as selected, conforming to ASTM C 920. Base material shall be urethane.

2.4.2 Latex

Latex Sealants shall be single component, color as selected, conforming to ASTM C 834.

2.5 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

Unsound substrates shall be repaired. Joint dimensions and surfaces receiving substrates shall be verified that they comply with the manufacturer's recommendations.

3.2 PREPARATION

Prepare and prime joints in accordance with manufacturer's instructions. Adjacent exposed surfaces shall be protected.

3.3 INSTALLATION

Backup material shall be installed with a blunt tool.

Backup material shall be 33 percent oversize for closed cell material, unless otherwise indicated.

Sealants shall be applied within recommended temperature and humidity conditions.

Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags.

Sealant shall be installed to cover the following conditions:

Openings .25 inch and less between walls and partitions and adjacent casework, door frames, built in or surface mounted equipment and fixtures.

Perimeters of frames of doors, window, and access panels which adjoin exposed interior concrete and masonry surfaces.

Joints between interior masonry walls and partitions and columns, pilasters, concrete walls, or exterior walls unless detailed otherwise.

Seats of metal thresholds for doors.

Other interior locations where small voids between materials require filling for first class workmanship and painting.

3.4 INSPECTION AND ACCEPTANCE PROVISIONS

All work shall be inspected for proper installation. Calking and sealing shall be rejected for the following deficiencies:

Calking compound having a finished surface not conforming to specifications.

Sealing compound with color not matching the sample or surface not complying with specifications.

Sealing compound failing to adhere to side surfaces of joints.

3.5 CLEANING AND REPAIRING

Surfaces adjoining joint excess and smears resulting from installation shall be cleaned.

Defective work shall be removed and replaced with calking and sealing materials as indicated.

3.6 PROTECTION

Installed sealants shall be protected until cured.

-- End of Section --

SECTION 08100
METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2004) Structural Welding Code - Steel

DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1 (1990) Preparation for Mortise Locks for 1-3/8 Inch 35 millimeter and 1-3/4 Inch 44 millimeter Doors

DHI A115.2 (1988) Door and Frame Preparation for Bored or Cylindrical Locks for 1-3/8 Inch 35 millimeter and 1-3/4 Inch 44 millimeter Doors

DHI A115.4 (1994) Standard Steel Door and Frame Preparation for Lever Extension Flush Bolts

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80 (1999) Standard for Fire Doors and Fire Windows

STEEL DOOR INSTITUTE (SDI)

SDI 100 (1998) Standard Steel Doors and Frames

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation drawings for the following items shall be in accordance with the paragraph entitled, "Installation," of this section.

Frames

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Frames
Finish Hardware
Reinforcement

SD-07 Certificates

Certificates for the following items shall be submitted showing conformance with referenced standards contained in this section.

Frames

1.3 DELIVERY, HANDLING, AND STORAGE

Doors, frames, and accessories shall be protected from damage during handling, transportation, and at the job site. Materials shall be stored at the site, under cover, and on wood blocking or suitable floors.

PART 2 PRODUCTS

2.1 GENERAL

Doors, frames, and accessories shall conform to SDI 100 and the requirements specified herein.

Welding shall be in accordance with the recommended practice of the Structural Welding Code, Sections 1 through 6, AWS D1.1/D1.1M and as specified by the producer of the metal being welded. Welds behind finished surfaces shall cause no distortion or discoloration on the exposed side.

2.1.1 Frames

Interior frames shall be 16-gage full welded-unit type.

Fire-rated frames shall be the types that have been investigated and fire tested as an assembly, complete with the type of hardware to be used in the work. Fire-rated frames shall be labeled with the applicable fire rating of the frame construction provided.

2.2 FINISH HARDWARE PREPARATIONS AND LOCATIONS

Preparation for hardware shall be in accordance with DHI A115.1, DHI A115.2, and DHI A115.4, as applicable.

Hardware locations shall comply with SDI 100, Table V, except when template dimensions and multiple-item installations require an alternative location.

Reinforcement for finished hardware shall meet or exceed the requirements of SDI 100, Table IV.

2.3 FINISHING

Doors and frames shall be primed and finished in accordance with SDI 100.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Door Clearance

Clearances for fire-rated doors shall be as specified in NFPA 80.

3.1.2 Frame Installation and Tolerances

Fire-rated frames shall be installed in accordance with NFPA 80.

Frames shall be installed within the following tolerances:

Deviation in location from that indicated on the drawings	Plus or minus 1/4 inch
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Deviation from plumb or horizontal:

In 8 feet	Not more than 1/16 inch
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In 12 feet	Not more than 1/8 inch
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3.1.3 Finish-Hardware Installation

Hardware shall be installed and adjusted in accordance with the hardware manufacturer's printed directions.

After the installation is completed, hardware shall be adjusted and lubricated to ensure proper performance.

3.1.4 Final Adjustment

Before final acceptance, finish hardware shall be checked and readjusted as required to ensure proper operation of the finish hardware.

-- End of Section --

SECTION 08210

WOOD DOORS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

WINDOWS AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

NWWDA I.S. 1 (1999) Wood Flush Doors

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Fire Rated Labeled Doors
Thresholds

PART 2 PRODUCTS

2.1 GENERAL

Doors shall comply with the requirements of NWWDA I.S. 1, and as specified.

2.1.1 Fire-Rated Labeled Doors

Fire-rated doors and frames shall be the types that have been investigated and fire tested as a fire door assembly, complete with the type of fire-door hardware to be used in the work. Fire-rated doors and frames shall be labeled. The labels shall indicate the applicable fire rating of the door construction provided.

2.2 FACING

Facings indicated as stain-transparent finish shall be premium grade conforming to NWWDA I.S. 1. Face veneer and veneer cut shall be:

Natural Birch, Plain Slice

2.3 CUTOUT OPENINGS

Cutout openings for lights and louvers shall be made in accordance with NWWDA I.S. 1.

2.4 BEVELING AND FITTING

Beveling and standard prefitting of wood doors shall be in accordance with NWWDA I.S. 1.

2.5 EDGE SEALING

Top and bottom edges of doors and surfaces of all cutouts shall be factory-sealed against moisture penetration.

2.6 DOOR FINISHING

Doors to receive a job-site-applied finish shall be clean and sanded smooth to remove handling and storage marks, raised grain, minor surface marks, and abrasions and shall be left ready for finishing as specified in Section 09915 PAINTING.

2.7 THRESHOLDS

Metal thresholds shall be provided where indicated. Thresholds shall be extruded aluminum, 6063-T5 alloy, mill finish, not less than 1/8 inch thick, with integral seal grooves formed to the indicated section.

Threshold for single door shall be equal to Zero International #566A and for pair of doors, Model #56A.

PART 3 EXECUTION

3.1 GENERAL

Doors shall be accurately installed in framed openings and shall maintain the specified clearances and tolerances.

Finish Hardware sets shall be installed in accordance with the approved hardware schedule and the approved drawings. Hardware shall be temporarily removed as required for job-site finishing.

After finish staining and painting has been completed, hardware and accessories shall be reinstalled and final adjustments made for proper door operation.

3.2 ACCEPTANCE PROVISIONS

Doors will be checked by the Contracting Officer for warp, twist, delamination, and manufacturing and installation defects. Doors exhibiting defects and doors outside the tolerances listed in NWWDA I.S. 1 shall be removed and replaced with new doors.

-- End of Section --

SECTION 08300

CLEANROOM SLIDING DOOR

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

American National Standards Institute

ANSI 156.10

American National Standard for Power
Operated Pedestrian Doors

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall include STC ratings, and UL fire rating, where applicable, for the following items:

Cleanroom Sliding Door
Thresholds

SD-02 Shop Drawings

Installation drawings for the following items shall include a finish hardware schedule for each door and a schedule indicating profile, dimensions, hardware reinforcement, and frame anchorage.

Cleanroom Sliding Doors

PART 2 PRODUCTS

2.1 CLEANROOM SLIDING DOOR

MARATHON CleanSeal Model 250 Single Piece Horizontal Sliding Cleanroom Door or approved equal.

Other acceptable manufacturers are:

Besam; Unislide with EZ-Fit EMD-II Microprocessor control.
Horton Automatics: Series 6-2000, Ultra Clean Atmospheric
Automatic Sliding Door & Operator, Model P-SX,

Door size to be 7' x 7'-6" with 36" net slide open.

Doors shall be electric power operated, Single Piece Horizontal Sliding Cleanroom doors. Door speed: 24"/sec. open; 18"/sec. close.

Door panel shall consist of two molded fiberglass reinforced polyester

shells surfaced with white (specify if other color is required) polyester gel-coat and bonded into a seamless unit. Corners and edges to be reinforced to a thickness of 5/8". Panel to be reinforced with an internal 16 gauge channel steel frame with 1/4" steel attachment plates at top for attaching panels. Also, a 20 gauge stainless steel edge capping will be attached on all four sides of panel for added strength and protection.

2" thick panel to be unitized and filled with pour-type polyurethane foam insulation (rated at R-16) having a "K" factor of .12 at 75° F.

Door actuation to be provided by:

Two wall mounted push plates with time delay close.

Rail and truck assembly to be heavy duty stainless steel construction. Truck assembly to incorporate adjustments in both the vertical and horizontal planes for optimal sealing.

Provide an adjustable guide roller on trailing edge base of door, attached to an 11 gauge stainless steel plate mounted to the side frame. (Hardware attached to the floor will not be accepted.)

Provide a stainless steel hold-in/guide device at the leading edge base of the door attached to an 11 gauge stainless steel plate, mounted to the side frame. (Hardware attached to the floor will not be accepted.)

Gasket at sides, head and sill to be gray vinyl, non-marking, blade type, capable of holding a seal under positive/negative pressures.

Side frames to be two piece stainless steel construction, 16 gauge. When attached to the wall, bolt heads, nuts, or fastener covers will not be visible. (Frames requiring these items will not be accepted.)

Hardware to include stainless steel recessed handles and stainless steel floor hardware. Truck wheels to be nylon with factory sealed ball bearings. Complete rail and truck hardware to be stainless steel and mounted on a stainless steel header.

Power drive system to be electromechanically operated, and belt driven for smooth, high speed operation. Motor to be 1/4 hp, 230/460 volt, 60 cycle, 3 phase. Electrical controls to be enclosed in a NEMA-4 rated enclosure. Limit switches to provide infinite adjustment without special tools.

Electromechanical operator to be used in conjunction with a variable speed drive system which controls acceleration, deceleration and stopping of door. Operators using brakes to stop door motion are not allowed.

Entire header, rail, and operator assembly to be enclosed by a 16 gauge stainless steel shroud, with a sloped top. All fasteners must be on the bottom of the shroud. (Hoods with visible fasteners on the top or front face will not be accepted.)

Send and receive reversing photo eye mounted in the side frame. (A photo eye mounted on the wall or utilizing a reflector will not be accepted.)

No disconnect needed to run door manually in case of power failure. (Doors requiring mechanical disconnects will not be accepted.)

Door panel to be equipped with an electric, fail safe reversing edge

effective full height and full travel of door.

PART 3 EXECUTION

3.1 EXAMINATION

Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes your acceptance of conditions as satisfactory.

Verify opening size, dimensions and tolerances.

3.2 PREPARATION

Protect surrounding areas and surfaces to prevent damage during work of this section.

3.3 INSTALLATION

Install the work in accordance with manufacturer instructions.

Install operator in accordance with ANSI 156.10.

-- End of Section --

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ALUMINUM ASSOCIATION (AA)

AA 45 (2003) Designation System for Aluminum Finishes

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1 (2000) Butts and Hinges
BHMA A156.13 (2002) Locks and Latches, Mortise
BHMA A156.16 (2002) Auxiliary Hardware
BHMA A156.18 (2003) Hardware - Materials and Finishes
BHMA A156.21 (2001) Thresholds
BHMA A156.3 (2001) Exit Devices
BHMA A156.4 (2000) Door Controls (Closers)
BHMA A156.5 (2001) Auxiliary Locks & Associated Products
BHMA A156.6 (2001) Architectural Doors and Trim

STEEL DOOR INSTITUTE (SDI)

SDI 100 (1998) Standard Steel Doors and Frames

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Finish Schedule
Hardware Schedule
Material, Equipment and Fixture Lists
Finish Hardware b

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Fasteners
Hinges
Locksets
Exit Devices
Thresholds
Closers
Door Holders
Door Stops
Door Silencers
Metal Kick Plates
Door-Sill and Jamb Sound Control System

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be provided by the Contractor in accordance with paragraph entitled, "General," of this section.

1.3 GENERAL

A Finish Schedule shall include a Hardware Schedule indicating the door and frame location, type, size, swing, bevel, material, hardware type by Builders' Hardware Manufacturers Association (BHMA) numbers, and the respective manufacturer's type, name, number, finish, and design. Material, Equipment and Fixture Lists shall be provided prior to the hardware schedule, showing a list of the proposed Finish Hardware by manufacturer, type, name, series, material and finish.

Manufacturer's Instructions for finish hardware shall indicate the manufacturer's recommended method and sequence of installation.

PART 2 PRODUCTS

2.1 FASTENERS

Fasteners of the proper type, size, quantity, and finish for each hardware item shall be provided. All visible fasteners shall be phillips-head, bronze or stainless steel finished to match specified hardware.

2.2 HINGES

Hinges shall be full mortise, heavy weight, 5-knuckle, anti-friction bearing, hospital tip, template type conforming to BHMA A156.1, Grade 1. Size shall be 4-1/2 by 4-1/2 inches.

Hinges shall be equal to Hager BB1168HT. US26D Finish

2.3 LOCKSETS

2.3.1 General

Mortise locksets and latchsets shall conform to BHMA A156.13.

Locksets and latchsets shall have standardized fronts, cases, and strikes so that varying functions will be interchangeable and will require only one mortise for their installation. Locks and latches shall have beveled bronze fronts, bronze bolts and strikes, brass hubs, and cases with specified finish. Locks shall have cylinders conforming to BHMA A156.5.

Locksets and lock cylinders shall be master keyed to the key system established for the installation.

Core shall be compatible with Best 7-pin with removable core. Dogging to be standard single-point quarter turn.

2.3.2 Mortise Locksets

Mortise locksets and latchsets for fire-rated doors shall be UL listed and labeled, heavy duty, Series 1000, Grade 1.

2.4 EXIT DEVICES (PANIC HARDWARE)

Exit devices shall be Surface Mounted Vertical Rod Type as defined in BHMA A156.3.

Pushbar exit device shall be equal to Corbin Russwin ED5400 with stainless steel finish. Conform to ANSI F08. Provide N755. Install upper and lower strikes as recommended by manufacturer.

2.5 SOUND CONTROL SYSTEM

Provide Z-1 System for a maximum air exfiltration leakage of 0.02 cfm/lf at 25 mph velocity as manufactured by Zero International or approved equal. Head and jamb shall have #475A aluminum frame-mounted seals with neoprene inserts. Provide surface mounted automatic door bottom #365A with watershed #141.

Doors shall have sill protection sweep. Zero International model #37S or approved equal.

2.6 THRESHOLDS

Thresholds shall be extruded aluminum 6063-alloy mill finish conforming to BHMA A156.21. Provide #565A for door 1 and #566A for door 2 with neoprene gaskets.

Thresholds shall be provided for the full width of the opening.

2.7 CLOSERS

Closers shall conform to BHMA A156.4.

Closers shall be the surface mounted heavy duty, parallel arm type, Grade 1. Style shall be modern. Closer shall be equal to LCN 4110 Cush-N-Stop.

Brackets, reinforcing plates, and accessory fittings shall be provided as required.

2.8 COORDINATING DEVICE

A coordinating device shall be provided for each pair of doors with an overlapping astragal or with rabbeted stiles.

Coordinating devices shall conform to BHMA A156.3, stainless steel, finish to match the locksets.

2.9 MISCELLANEOUS AND SHELF HARDWARE

2.9.1 General

Miscellaneous hardware shall conform to BHMA A156.16, except as noted, and shall match or have the same finish as lockset finish.

2.9.2 Door Stops

Door stops and bumpers shall conform to BHMA A156.16.

Wall mounted stops shall be Type L02101 (wall bumper). Where impossible to install wall mounted stops, floor mounted stops, Type L02141 (dome type) or Type L02161 (dome type for door with thresholds) shall be provided.

2.9.3 Metal Kick Plates

Plates shall be 0.050-inch thick stainless steel, bevel edge, Type J101 (Armor), Type J102 (Kick), or Type J103 (Mop), conforming to BHMA A156.6, finish as specified herein. Width of kick plates shall be 2 inches less than the door width. Height of kick plates shall be 8 inches. When the bottom rail of the door is less than 8-1/2 inches, the kick plates shall extend to within 1/2 inch of the panel mold or bead.

2.10 FINISHES

Hardware shall receive the following finish(es) conforming to BHMA A156.18, as follows:

Hinges at labeled openings	US26D
Exit bolts (panic hardware)	Match locksets and latchsets
Closers	Sprayed, matching locksets and latchsets
Door stops, door holders, soundseals, astragals	Match locksets and latchsets

Aluminum hardware items shall be anodized to an Architectural Class II natural finish not less than 0.4-mil thick conforming to AA 45 (designation AA M21 C22 A31).

PART 3 EXECUTION

3.1 GENERAL

Hardware shall be installed and adjusted in accordance with the hardware manufacturer's printed instructions and to template dimensions.

Temporary-construction cores shall be furnished, installed, and maintained in locks during construction and removed when directed.

Install saddle using fasteners and sealants as recommended by manufacturer to maintain allowable air leakage rate.

3.2 HARDWARE LOCATION

Hardware shall be located in accordance with SDI 100, Table V, except when template dimensions and multiple-item installations require alternate locations.

3.3 HARDWARE SCHEDULE

-- End of Section --

SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 111 (1990) Standard Specification for Zinc
(Hot-Dip Galvanized) Coatings on Iron and
Steel, Products

ASTM INTERNATIONAL (ASTM)

ASTM A 1011/A 1011M (2004) Steel, Sheet and Strip, Hot-Rolled,
Carbon, Structural, High-Strength
Low-Alloy and High-Strength Low-Alloy with
Improved Formability

ASTM A 641/A 641M (2003) Standard Specification for
Zinc-Coated (Galvanized) Carbon Steel Wire

ASTM C 36 (1995) Gypsum Wallboard

ASTM C 473 (2003) Physical Testing of Gypsum Board
Products and Gypsum Lath

ASTM C 475/C 475M (2002) Joint Compound and Joint Tape for
Finishing Gypsum Board

ASTM C 553 (2002) Standard Specification for Mineral
Fiber Blanket Thermal Insulation for
Commercial and Industrial Applications

ASTM C 645 (2004) Nonstructural Steel Framing Members

ASTM D 2103 (2003) Standard Specification for
Polyethylene Film and Sheeting

ASTM E 119 (2000a) Standard Test Methods for Fire
Tests of Building Construction and
Materials

ASTM E 84 (2003) Standard Test Method for Surface
Burning Characteristics of Building
Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2003) Life Safety Code (National Fire
Codes, Vol 5)

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1793

(2003) Architectural Sheet Metal Guideline

1.2 SYSTEM DESCRIPTION

Manufacturer's catalog data shall be submitted Special Framed Openings and Rated Wallboard Assemblies, meetin all design specifications as required by referenced standards within this section. Data shall include fire ratings, sound transmission classification, and permeance requirements where applicable.

Certificates shall be submitted for gypsum wallboard systems indicating that the proposed materials meet or exceed the project specifications and the listed reference specifications.

1.2.1 Partition Configurations

1.2.1.1 Single-Layer Partitions

Single-layer drywall partitions shall be fire-retardant gypsum wallboard, thickness as indicated.

Furred drywall on exterior masonry walls shall be fire retardant gypsum wallboard, thickness as indicated.

1.2.2 Performance Requirements

1.2.2.1 Fire Retardant Requirements

Walls separating lab from corridor shall be maintained as 1 hour fire walls. Contractor shall infill all existing openings as required to achieve a 1 hour rating. Provide fire stops around electrical, plumbing and mechanical penetrations.

Type X gypsum wallboard shall provide at least 1 hour fire-retardant rating for 5/8-inch thick material or 3/4-hour fire-retardant rating for 1/2-inch material when applied in single-layer, nailed on each face of load-bearing, wood framing members, and when tested in accordance with ASTM E 119.

When tested in accordance with ASTM E 84, gypsum wallboard shall have a maximum flame-spread rating of 15, fuel contributed 15, and smoke developed 15.

1.2.2.2 Ceiling Assembly Fire Ratings

Gypsum drywall ceiling assembly shall have a fire rating of 1 hour. Drywall construction shall be in accordance with the UL design and test as listed by the drywall manufacturer.

1.2.2.3 Permeance Requirements

Back gypsum wallboard shall meet the permeance requirements specified in ASTM C 36.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items including fire ratings, sound transmission classification, and permeance requirements where applicable.

Gypsum Wallboard
Furring
Hangers and Inserts
Suspension
Channels
Resilient Channels
Joint Tapes
Steel-Stud Framing
Metal-Framed Drywall Ceilings
Fasteners
Adhesives
Floor and Ceiling Runners

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be protected from weather, soil, and damage during delivery, while stored, and during construction.

Materials shall be delivered in the manufacturer's original packages; containers or bundles shall bear the brand name and the name of the manufacturer.

Materials shall be stored in dry, weathertight, and properly ventilated areas.

Gypsum wallboard shall be neatly stacked flat, with care taken to avoid sagging or damage to edges, ends, and surfaces.

Wallboard delivered to the building shall be kept protected and banded with midpoint slat spaces of 2 by 1/2-inch material extended full width between each layer of gypsum wallboard.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

1.5.1.1 Temperature

A temperature of not less than 55 degrees F shall be provided in areas of work during the application of the materials and shall be maintained until the joint treatment compounds are dry.

1.5.1.2 Ventilation

Ventilation shall be provided to eliminate moisture within the building.

1.5.1.3 Moisture Control

Gypsum wallboard installation and joint treatment shall be accomplished in a uniform temperature with sufficient ventilation to ensure that throughout the application period the wallboard moisture does not exceed 8 percent.

Wallboard that has a moisture content in excess of 8 percent shall not be installed.

1.5.2 Field Measurements

Field measurements shall be taken before installation of materials to verify the indicated dimensions and to ensure proper fit of the work.

PART 2 PRODUCTS

2.1 WALLBOARD MATERIALS

2.1.1 General Requirements for Wallboard

Gypsum wallboard shall conform to ASTM C 36 of grade and form as specified for each type of board. Wallboard shall be 48-inches wide, shall have thickness as indicated, and a maximum practical length for end use.

2.1.2 Ceiling

Board for drywall ceilings shall be 5/8-inch thick, fire-retardant insulated gypsum wallboard.

2.1.3 Fire-Retardant Gypsum Wallboard

Fire-retardant gypsum wallboard shall be Grade X, Form a, at least 5/8 inch thick.

2.1.4 Joint Materials

2.1.4.1 Joint Tapes

Joint tape shall be plain or perforated material conforming to ASTM C 475/C 475M, Type II, Styles 1 and 2.

2.1.4.2 Compounds and Adhesives

Joint compound shall be an adhesive, without fillers, conforming to ASTM C 475/C 475M, Type I, Style 1.

Laminating adhesive shall be joint compound of the type used for embedding tape or a material recommended by the manufacturer of the gypsum board. Ready-mixed joint compound (Style 3) shall not be used as laminating adhesive.

2.1.5 Metal Fasteners

Screws shall be steel, self-tapping drywall type, bugle head, self-drilling point; the length shall be as recommended by the drywall manufacturer for the type of system being installed.

Screws for anchorage of runner channels to studs and securing gypsum backing board to metal studs and furring channels shall be 1 inch long.

Screws for temporary support of gypsum wallboard face ply shall be 1-5/8-inches long of the same type.

2.1.6 Metal Framing Materials

2.1.6.1 Hangers and Inserts

Wire hangers for main runner channels shall be galvanized soft steel wire not less than 28-gage, conforming to ASTM A 641/A 641M, steel number 1010, Class 2 zinc coating.

Hot-dip galvanized flat steel hangers 1 by 3/16 inch; galvanized concrete insert-type rod hangers may be substituted for wire hangers.

Tie wires for splicing furring channels or for securing furring channels to main running channels shall be galvanized soft steel wire not less than 16-gage with Class 2 zinc coating.

2.1.6.2 Suspension, Furring, and Channels

Channels shall be formed from galvanized steel sheets conforming to SMACNA 1793, Type I, Class d, ordinary zinc coated (commercial).

Main runner channels shall be 1-1/2-inch, hot- or cold-rolled, galvanized steel. Hot-rolled channels shall weigh not less than 1.12 pounds per linear foot. Cold-rolled channels shall be not less than 16-gage uncoated steel with flanges at least 19/32-inch wide.

Furring channels shall be roll-formed, galvanized steel not less than 0.021 inch thick before galvanizing, with steel face width of 1-3/8 inches and a depth of 7/8 inch, and shall have reinforced, folded edges.

Furring channels for miscellaneous framing shall be 3/4-inch wide, cold-rolled galvanized steel not less than 16-gage before galvanizing, and shall weigh not less than 0.33 pounds per linear foot.

Nailing channels 3/4 by 7/8 inch shall be cold-rolled, electrogalvanized steel not less than 25-gage before galvanizing, and shall be formed with a continuous lip to retain ratchet nail fasteners.

2.1.6.3 Resilient Channels

Resilient channels shall be the gypsum drywall manufacturer's standard design for sound-attenuating channel members.

2.1.6.4 Steel-Stud Framing

Steel studs, floor and ceiling runners, angle runners, and furring channels shall be electrogalvanized, cold-rolled steel conforming to ASTM C 645 ordinary zinc coated (commercial).

Metal studs shall be formed, zinc-coated sections of channel or Z-shape, of 26-gage minimum thickness, and of widths indicated on the drawings. Stud flanges that come in contact with gypsum wallboard shall be a minimum of 1-1/4 inches wide, with a 1/4-inch stiffening lip with turned or folded edges. Holes shall be regularly punched in studs to facilitate installation of electrical wiring, conduit, or horizontal bracing.

Floor and ceiling runners shall be not less than 26-gage steel before

galvanizing, with 1-1/4-inch flanges, sized to nest with steel stud.

Angle runners shall be 1-3/8 inches by 7/8 inch and not less than 22-gage.

2.1.7 Metal Accessories and Trim

2.1.7.1 Corner Beads and Trim

Corner beads shall be 30-gage minimum, hot-dip galvanized steel, with 1-1/4- by 1-1/4-inch flanges and a 1/8-inch beaded corner.

Corner beads shall be formed to an angle of 90 degrees and shall be zinc-coated steel not lighter than 30-gage before coating with wings not less than 7/8-inch wide and perforated for nails and cement treatment. Zinc-coated steel shall conform to SMACNA 1793, and AASHTO M 111, Type I, Class C.

Casing trim shall be 28-gage nominal thickness, hot-dip galvanized steel channel, depth as required for wallboard, with attached tape flange.

2.1.7.2 Metal Base

Metal base shall be fabricated from hot-rolled strip steel, commercial quality, in accordance with ASTM A 1011/A 1011M and shall be 2-1/2-inches wide, (18-gage), flush face or reveal face as indicated, factory primed with manufacturer's standard rust-inhibiting primer, with welded exterior corners, splice, and attachment plates.

2.1.8 Control Joint Material

Control joints shall be formed of casing bead trim and installed back to back over separate framing or furring members. A space of 3/16 inch shall be maintained between opposite casing beads.

2.1.9 Calking

Control joint calking shall be as recommended by the drywall manufacturer and shall be the same type used for partition and ceiling assemblies when the fire rating and STC were established.

2.1.10 Dust Membrane

Dust membrane shall be clear, 4-mil polyethylene film, conforming to ASTM D 2103, Type 13000.

2.1.11 Fire-Insulation Blankets

Insulation shall be semirigid, paperless, spun mineral-fiber mat, thickness and width as indicated, and shall conform to ASTM C 553. Material shall be UL listed with a Class A fire-hazard classification as defined in NFPA 101; flame spread shall not exceed 25, fuel distributed 20, smoke developed 0 when tested in accordance with the tunnel test of ASTM E 84.

2.2 SOURCE QUALITY CONTROL

Gypsum wallboard shall be tested at the manufacturing plant in accordance with ASTM C 473 for flexural strength, thickness and weight of paper and predecorated board surfacing, and thickness of edge of recessed or

tapered-edge gypsum wallboard.

PART 3 EXECUTION

3.1 PREPARATION

Defective wall and ceiling surfaces shall be corrected prior to application of drywall materials.

3.2 ERECTION, INSTALLATION, AND APPLICATION

3.2.1 Framing

Framing members to receive gypsum wallboard shall be straight, plumb, and true and spaced not to exceed the maximum spacings for the board thickness.

3.2.2 Board Length

Boards of maximum practical length shall be used to minimize the number of end joints. Edges of boards shall be butted together but shall not be forced.

3.2.3 Staggering Boards

Joints shall be staggered and shall not be aligned with the edge of an opening nor positioned so that the corners of four boards will meet at a common point.

3.2.4 Joints

All abutting ends or edge joints shall occur over solid bearing, (wood joists, wood furring, or over the web surface of furring channels) and shall be fitted neatly and accurately, with all end joints staggered. Wallboard shall be supported as recommended by the manufacturer, with additional framing at all cutouts and openings.

3.2.5 Ceiling Abuts Dissimilar Wall

Perimeter of ceilings shall be finished with an edge bead trim where ceiling abuts dissimilar wall materials.

3.2.6 Wall Trim

Trim shall be applied to wall and accurately aligned with the finished ceiling. Ceiling board edges that adjoin walls shall be laid on the horizontal leg of the trim strip, and the space behind the junction shall be closed with a dust membrane. Membrane shall be applied in advance of the wallboard application.

3.2.7 Corners and Edges

Exposed corners and edges and the perimeter of door, window, and borrowed-light frames shall be finished with the specified metal trim.

3.2.8 Tolerance and Alignment

Finished wallboard application shall be plumb and true, with all joints aligned to within a 1/16-inch tolerance and with all surfaces shimmed and aligned to a plane and even surface having a maximum variation of 1/8 inch

in 8 feet.

3.2.9 Midheight Horizontal Bracing

Midheight horizontal bracing shall be continuous in partitions for all heights above 8 feet 6 inches. Bracing shall be standard runner channel for stud size specified. Channel shall be secured rigidly in place at each stud.

3.2.10 Partition Bracing

Where gypsum wallboard partitions do not extend to the underside of construction above, they shall be braced at the top channel with a V-frame perpendicular to the line of the partition located 18 feet 8 inches maximum on center where partitioning is not intersected or otherwise braced. V-braces shall be composed of two 2-by 2-by 1/8-inch angles attached to metal clips. When brace is in final position, it shall be welded, or holes shall be drilled and the brace bolted in permanent position. Partitions shall not exceed 16 feet in height.

3.2.11 Ply

Wallboard shall be applied to ceilings in single-ply, with the long dimension of the wallboard at right angle to the furring members as specified herein and in accordance with the drywall manufacturer's instructions for the type and classification of wall assembly indicated.

Wallboard shall be applied to walls in single-ply, horizontal and vertical application, and in two-ply as specified herein and in accordance with the drywall manufacturer's instructions for the type and classification of wall assembly indicated.

3.2.12 Fastening

Board shall be fastened with power-driven, phillips-head screws at a maximum spacing of 12 inches on center in the field of the board and at 8 inches on center at edges and along abutting ends shall be placed not closer than 3/8 inch to ends or edges of boards.

3.2.13 Installation of Control Joints

Control joints shall be provided where indicated and shall be screwed in place.

3.2.13.1 Ceiling

Ceiling control joints fastened securely in place shall be provided at spacing not to exceed 50 feet in each direction.

3.2.13.2 Vertical

Vertical control joints in long runs of drywall partitions shall be provided at spacing not to exceed 30 feet on center; at partition intersections with structural floors and columns; and at walls of dissimilar materials.

3.2.13.3 Abutting Concrete Slabs

Where tops of drywall partitions abut concrete slab floors, a 1/2 inch gap

for deflection shall be provided between the top of stud and bottom of floor slab. A double slip track consisting of an inside and outside deep leg track shall be provided with studs screwed to the inside track. Runner tracks shall be embedded in calking or in an adhesive recommended by the drywall manufacturer, then stub-nailed in place.

3.2.14 Acoustical Sound Barrier

Glass-fiber insulation shall be provided as required for an acoustical sound barrier. Where drywall partitions abut structural columns or dissimilar wall materials, 1/2-inch of insulation shall be provided between web of stud and column or wall.

3.2.15 Trim

Edges of exposed drywall shall be trimmed with the specified metal bead.

3.2.16 Framed Openings

Support members shall be provided at ceiling openings as required for access panels, recessed lighting fixtures, and heating and ventilating ducts.

Support members shall be not less than 1-1/2-inch main runner channels located where required and shall be provided in sufficient number to support furring and wallboard attachment.

3.2.17 Joint Finishing

Joints between wallboard panels and joints at metal trim shall be reinforced with joint tape and embedding-type joint compound and concealed with at least two applications of finishing compound in accordance with the printed instructions of the manufacturer of the gypsum wallboard. Screw depressions shall be filled with at least three coats of joint compound. Flanges at corner beads, edge trim, and control joints shall be concealed with at least two applications of joint compound, feathered and sanded smooth.

Joint and screw-depression treatment shall be accomplished after wallboard is in place. A minimum of 24 hours' drying time shall be allowed between the application of each coat. Where necessary, the last coating shall be sanded lightly with 2/0 sandpaper to leave a smooth finish flush with the paper face of the wallboard.

3.2.18 Installation of Gypsum Drywall Ceilings

3.2.18.1 Metal-Framed Drywall Ceilings

Metal-framed drywall ceilings shall be installed and finished as specified and in accordance with the drywall manufacturer's written instructions for drywall ceilings installed over suspended or furred metal grilles and as required for the indicated fire rating and STC.

3.2.19 Steel Stud Framing

Floor and ceiling runner tracks shall be accurately aligned and securely attached to floors, structural ceilings, finished ceilings, or roof deck. Track shall be attached to concrete slabs with concrete stud nails.

Runners shall extend beyond open-end partitions for at least 12 inches. Upon installation of end studs, runner extensions shall be bent and nested with the stud and attached with at least two sheet metal screws.

Runners shall be furnished in longest practical lengths with butt joints.

Steel studs shall be size indicated, spaced at 24 inches on center. Maximum height span for 3-5/8-inch studs shall be 16 feet.

Studs for pipe chases, ventilating shaft framing, and steel column or beam fireproofing shall be the size indicated, spaced 16 inches on center.

Studs shall be positioned plumb in ceiling and floor runners and attached with at least one self-tapping screw on each side of the stud ends. Studs shall be installed in continuous lengths with no splicing.

Stud shall be placed no more than 1/2 inch from door frames, framed openings, abutting partitions, and partition corners. Studs shall be securely anchored direct or with spacers to door frames by screw attachment.

Top-runner channels of intersecting partitions shall have the web extended across the intersected channel. Extended web shall be fastened with two screws. Flanges of the intersecting channel shall be cut, bent, and fastened to the flanges of the continuously intersected channel with two screws in each flange.

Partition reinforcement shall be provided over door frame openings and, where required, for support of plumbing fixtures, accessories, and electrical and mechanical equipment. Reinforcement shall consist of cut-to-length sections of runner track or cold-rolled channels extending at least 2 feet on each side of the opening and braced and fastened to studs in accordance with the manufacturer's directions.

Head and jamb framing at door openings shall consist of a tube made up of one runner channel and one stud. Tubes at door jambs shall extend the full height of the partition and shall be fastened together with screws at a minimum of 24 inches center-to-center each flange. Tube over the door head shall be fastened together with a minimum of three screws each flange. Runner channel section of the header tube shall be cut 12-inches longer than the span between the two jamb studs. A web bend shall be made with 6 inches extended in a vertical direction on each jamb tube and fastened with a minimum of two screws. Flanges shall be extended horizontally and fastened to the flanges of the vertical stud. Cut-to-length studs shall then be positioned at not more than 16-inch spacing over the door opening and secured to the tube with a web flange bend with a minimum of two screws. Runner channel sections of tubes shall be secured to the door frame head and jamb with two 1/4-inch machine bolts, nuts, and washers.

3.2.20 Steel Framed Drywall Partitions

3.2.20.1 Single-Layer Partition Over Steel Framing

Gypsum wallboard shall be applied and finished as specified and in accordance with the drywall manufacturer's written instructions for a UL-approved, 1-hour fire-rated, single-layer, screw-stud drywall partition, with an STC of at least 47. All perimeter joints shall be calked.

3.2.20.2 Metal Furring

Furring to receive gypsum wallboard shall be the specified galvanized-steel furring channels of the type and spacing as indicated. Clips and fasteners shall be provided as required for type of installation and in accordance with the wallboard manufacturer's written instructions. Furring members shall be installed plumb and true, shimmed to a plane surface, and spaced as indicated. Plane surface shall vary less than 1/8 inch in 8 feet.

Metal wall furring channels shall be installed vertically with horizontal spacing of not over 24 inches on center and shall be securely anchored to walls with suitable fasteners spaced 24 inches on center. Fasteners shall penetrate alternate wing flanges (staggered) of the furring channel. Metal wall furring channels shall also be placed horizontally at floors and ceilings; at heads of door frames; over and under wall louvers, access panels, and other opening in the walls, and shall be securely anchored as specified above.

3.2.21 Structural Frame Fireproofing

3.2.21.1 Column Fireproofing

Steel columns shall be fireproofed with two layers of 1/2-inch thick, Grade X fire-retardant, gypsum wallboard, as indicated and in accordance with the gypsum wallboard manufacturer's written instructions for a UL-approved, 1-hour fire-rated construction. Joints shall be finished. Exposed corners and edges shall be finished with metal corner beads as specified.

3.2.22 Surface Finishing

Surface defects and damage shall be corrected to leave wallboard smooth, uniform in appearance, and ready to receive finish as specified in other sections of these specifications.

All control joints shall be properly and completely filled with the specified sealant.

Joints shall be sanded when dry after each application of joint compound. Final finish shall be uniformly smooth and flush with the paper face of the wallboard.

Surfaces of the work, and adjacent surfaces soiled as a result of this work shall be cleaned.

-- End of Section --

SECTION 09514

ACOUSTIC CEILINGS, EXPOSED GRID

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM C 423	(2002a) Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C 635	(2000) Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(2003) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E 90	(2002) Standard Test Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions

1.2 PERFORMANCE REQUIREMENTS

1.2.1 Noise Reduction Coefficient Grade

Noise reduction coefficient (NRC) grade of acoustic ceilings shall be tested or certified by an approved testing laboratory in accordance with ASTM C 423, and shall be .85 NRC or better.

1.2.2 Ceiling Sound-Transmission Classification

Sound Transmission Classification (STC) of the indicated acoustic ceilings shall be an 11-frequency test method conforming to ASTM E 90, and shall be 41.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following drawings shall be submitted in accordance with paragraph entitled, "Acoustical Ceiling Information," of this section.

Installation Drawings

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items showing UL classification of fire-rated ceilings giving materials, construction details, types of floor and roof constructions to be protected, and UL design number and fire protection time rating for each required floor or roof construction and acoustic ceiling assembly.

Fire-Rated Ceiling Systems
Acoustic Materials
Suspension System Materials
Suspension Materials

SD-04 Samples

Samples of the following shall be submitted in accordance with paragraph entitled, "Acoustical Ceiling Information," of this section.

Acoustic Units
Suspension System Members
Anchorage Devices and Fasteners

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted showing printed instructions covering installation of Acoustic Materials and Suspension System Materials.

The Manufacturer's Instructions for preventive maintenance and inspection shall be submitted showing the acoustic material manufacturer's recommended cleaning and application methods.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered and stored in their original, unopened packages bearing labels clearly identifying manufacturer's name, brand name, material, type or class, UL listing when applicable, and other pertinent data.

Acoustic materials shall be stored in a weathertight and dry place, having a temperature not less than 65 degrees F and relative humidity not more than 70 percent, and for at least 24 hours prior to installation.

1.5 FIELD MEASUREMENTS

Field measurements shall be taken prior to preparation of drawings and fabrication, to ensure proper fitting of the work.

1.6 MAINTENANCE INSTRUCTIONS

The Contractor shall follow the acoustic material Manufacturer's Instructions for recommended cleaning and application methods, including precautions in the use of cleaning materials that may be detrimental to acoustic surfaces and the finish of exposed metal components.

1.7 ACOUSTICAL CEILING INFORMATION

Fabrication Drawings shall be submitted for exposed grid acoustic ceilings consisting of fabrication and assembly details to be performed in the factory.

Installation Drawings shall be submitted for exposed grid acoustic ceilings showing intermediate framing of hanger supports that fall between framing members; fastening of suspension system to top plate of nonbearing partitions; hanger fastenings at roof framing members and at main runners; acoustic unit support at ceiling fixtures; the splicing method for main and cross runners; positioning of splines; details of access acoustic tiles or panels; and the suspension system structural classification in accordance with ASTM C 635.

Samples of the following shall be submitted accordingly:

Acoustic Units: Three full-size samples of each type and pattern to illustrate the manufacturer's standard color and appearance range.

Suspension System Members: Three full-size samples of each type.

Anchorage Devices and Fasteners: Three full-size samples of each type.

PART 2 PRODUCTS

2.1 ACOUSTIC MATERIALS

2.1.1 Acoustic Panels

Tile shall be high density fiberglass core encapsulated in a PVF plastic film, nominal 24 x 48 inches by not less than 2 inch thick, mass loaded, with square water tight sealed edges.

Color shall be white.

Panel shall be equal to MBI San Pan Acoustical Panel Type 600PVF (Mass Loaded).

2.2 SUSPENSION SYSTEM MATERIALS

Grid system shall be Gordon, DS-38 2" Gasket-Seal Ceiling Grid and Suspension System or approved equal.

2.2.1 Grid System

The grid system shall be manufactured of 2" extruded aluminum alloy 6063, temper T5 with a 204-R1 etched and clear anodized finish, as specified. Grid profile shall have a continuous integral screw boss within the web for attachment of intersection connectors at any point along the grid members, and to facilitate ease of field installation. Cross tees to have square cut ends to create a fully non-progressive installation.

2.2.2 Gasket

The standard gasket tape shall be 1/4-inch thick x 5/8-inch wide black PVC. The gaskets shall be factory-applied, with precision cut ends, extended on grid members to ensure an airtight seal at all intersections.

2.2.3 Suspension system

Provide uni-strut support attached to steel beams as required to suspend grid system.

Model G-38 grid connectors - Heavy duty zinc alloy casting connectors shall be used at grid intersections and to suspend the grid system via 3/8-16 threaded rods. 1/4-20 phillips drive button head cap screws are used to fasten the connectors to the extruded aluminum grid members.

3/8-16 Threaded Starter Rod and Turnbuckle- ASTM rated RH/LH, 8" long, zinc plated, 3/8-16 threaded rod and 6" body zinc plated steel turnbuckle spaced at 48" centers or as required.

Ceiling system shall be level overall within 0.10" and shall be level within 0.062" in 10'-0".

PART 3 EXECUTION

3.1 COORDINATION

Coordinate all work with other trades to be performed in or on ceiling system including light fixtures, HVAC equipment, sprinkler systems and wall partition systems.

3.2 ACOUSTIC MATERIAL

Acoustic material shall be installed in accordance with the manufacturer's recommendations.

Seal all cut edges of acoustic ceiling panels with Tedlar tape.

3.3 CONDITIONS AT BUILDING

Work above the ceiling line shall be completed, and approved, prior to the start of acoustic work.

Spaces to receive acoustic materials shall be maintained at 60 to 85 degrees F and not more than 70 percent relative humidity for at least 48 hours prior to and during the installation of acoustic work, and until final acceptance.

Installation shall be per ASTM C 636, and as directed.

3.4 GRID INSTALLATION

3.4.1 Wall Angle Installation

Position wall angle at proper ceiling height on center of wall using laser leveling tool and attach with fasteners appropriate for existing wall type. Continue installing toward the corners and then around the room until complete. Corner can be field cut with a power miter saw using a carbide tipped blade. All joints must fit tight with no gaps.

3.4.2 Grid Installation

Position main tees at 48" or 48-1/2", or as required, perpendicular to wall angle taking care to align notches on main tee with notches on wall angle. Attach threaded rod to uni-strut with turnbuckle and rod attached to

connectors on grid. Uni-strut shall be attached to steel beams above.

Level entire ceiling to within 0.10" overall and/or 0.06" in any 10' length.

Brace grid for seismic conditions when required by local code. Install in accordance with UBC Standard No.47.18 and ICBO No 1461 for aluminum grid.

Peel backing off overhanging ends on gasket tapes and carefully affix to the grid member across the intersection seam and compressing into the gasket tape on the main runner. A tight fitting gasket intersection will assure the most airtight seal.

3.5 ARRANGEMENT OF ACOUSTIC CEILINGS

Acoustic units shall be so arranged that units less than one-half width do not occur unless otherwise required to suit conditions.

Ceilings shall be so arranged that either the tile joint or the tile centerline centers on ceiling fixtures.

Acoustic units shall be so arranged that joints are parallel with room axis in both directions, and straight and in alignment.

Runners shall be so arranged that the main runners are parallel with the room axis indicated, and in straight parallel alignment to each other.

3.6 MARKING LOCATION OF MECHANICAL SYSTEM CONTROLS

Access units in acoustic ceilings that are located directly below mechanical system controls shall be marked with an identification plate. Plate shall be 0.032 inch thick aluminum, 3/4 inch in diameter, stamped with the letters "AP" finished the same as the acoustic material, and attached by an approved method near one corner on the face of each access unit.

-- End of Section --

SECTION 09675

HEAVY DUTY EPOXY FLOORING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM C 413	(2001) Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes
ASTM C 580	(2002) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
ASTM D 2047	(2004) Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine
ASTM D 4060	(2001) Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D 4226	(2000) Standard Test Method for IMPACT Resistance of Rigid Poly (Vinyl Chloride) (PVC) Building Products
ASTM D 4541	(2002) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D 523	(1989; R 1999) Standard Test Method for Specular Gloss
ASTM D 635	(2003) Standard Test Method for rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D 638	(2002a) Standard Test Method for Tensile Properties of Plastics
ASTM D 790	(2003) Standard Test Methods for flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Epoxy-Resin Binder/Matrix
Surface Sealing Coat

SD-04 Samples

Samples of coating on Hardboard Panels shall be submitted in accordance with paragraph entitled, "Sampling," of this section.

SD-05 Design Data

Mix designs (Contractor and job) shall be submitted for the following items including a complete list of ingredients and admixtures. Applicable test reports shall verify that the mix has been successfully tested and meets design requirements.

Epoxy-Resin Binder/Matrix
Surface Sealing Coat

SD-06 Test Reports

A copy of the Records of Inspection after completion of the contract in accordance with paragraph entitled, "Quality Assurance," of this section.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be protected from weather, soil, and damage during delivery, storage, and construction.

Materials shall be delivered in original packages, containers, or bundles bearing brand name and name of material.

Materials used in the installation of floor topping shall be maintained at a temperature between 65 and 85 degrees F.

1.4 QUALITY ASSURANCE

A copy of the Records of Inspection, as well as the records of corrective action taken shall be submitted.

Single Source Responsibility: Obtain primary resinous flooring materials including primers, resins, hardening agents, finish or sealing coats from a single manufacturer with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Contractor shall have completed at least five projects of similar size and complexity; Stonhard or approved equal. Provide secondary materials only of type and from source recommended by manufacturer of primary materials.

1.4.1 Qualifications

A Listing of Product Installations for heavy duty epoxy flooring shall include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

Applicators installing the floor topping shall have had experience in the application of troweled walnut-shell aggregate thin-set floor topping.

1.4.2 Sampling

Three samples of Hardboard Panels not less than 12 inches square for each required color.

Panels shall show nominal thickness of finished toppings and color and texture of finished surfaces. Finished floor toppings shall match the approved samples in color and texture.

PART 2 PRODUCTS

2.1 COLOR

Color: As selected by Architect from manufacturer's standard colors.

2.2 MIX

2.2.1 Epoxy-Resin Binder/Matrix

Stonshield ATS (2 mm) as manufactured by Stonhard, Inc., Maple Shade, NJ, (800) 257-7953 or approved equal. Nominal 2mm/80 mil thick system comprised of a penetrating, two-component epoxy primer, a two-component conductive epoxy undercoat consisting of a resin and curing agent, brightly colored, quartz broadcast aggregate combined with conductive elements and a three-component, high performance, conductive, UV resistant, clear epoxy sealer.

Physical Properties: Provide flooring system in which physical properties of topping including aggregate, when tested in accordance with standards or procedures referenced below, are as follows:

<u>PROPERTY</u>	<u>TEST METHOD</u>	<u>REQUIREMENT</u>
Tensile Strength	ASTM D 638	1,600 psi
Flexural Strength	ASTM C 580	4,000 psi
Bond Strength	ASTM D 4541	>400 psi (100% concrete failure)
Impact Resistance	ASTM D 4226	>160 in. lbs.
Abrasion Resistance Taber Abrader CS-17 wheel	ASTM D 4060	0.06 gm max. weight loss
Flexural Modulus of Elasticity	ASTM D 790	5.0 x 10 ⁶ psi

<u>PROPERTY</u>	<u>TEST METHOD</u>	<u>REQUIREMENT</u>
Flammability	ASTM D 635	Self-Extinguishing. Extent of burning 0.25 inches max.
Thermal Coefficient of Linear Expansion	ASTM C 531	1.8×10^{-5} in/in°C
Coefficient of Friction	ASTM D 2047	0.7
Water Absorption	ASTM C 413	0.1%
Heat Resistance Limitation		140°F/60°C (for continuous exposure) 200°F/93°C (for intermittent spills)
Cure Rate allow:		24 hours for foot traffic 48 hours for normal operations

Static Control Properties: Provide flooring system in which static control properties of topping including aggregate, when tested in accordance with standards or procedures referenced below, comply with the ANSI/SED S20.20 specification for the protection of electrical and electronic parts, assemblies, and equipment:

Surface Resistance	$<1 \times 10^9$
Body Voltage	<100 Volts

2.2.2 Surface Sealing Coat

Surface sealer shall be nonambering aliphatic or aromatic moisture-curing polyurethane into which has been incorporated a suitable flatting agent. Flatting agent shall be added not more than 24 hours prior to actual application of the coating. Cured coating with flatting agent shall give 60-degree specular gloss of 10 to 20 when tested in accordance with ASTM D 523.

2.3 JOINT SEALANT

Type produced by manufacturer of resinous flooring system for type of service and joint condition indicated.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Safety Precautions

Prior to application in confined spaces of toppings and coatings containing flammable or toxic properties, forced ventilation shall be provided to ensure that vapor concentration is kept at acceptable limits recommended by the manufacturer of the product.

"NO SMOKING" signs shall be erected, and smoking or use of spark- or flame-producing devices shall be prohibited within 50 feet of any mixing or

placing operation involving flammable materials.

Personnel required to handle, mix, or apply toppings containing toxic or flammable properties shall be provided with, and required to wear, such items of personal protective equipment and apparel for eye, skin, and respiratory protection as are recommended by the manufacturer of the product.

Sand blasting shall be accomplished under approved controlled conditions with respect to sand and dust control to prevent damage to personnel and facility.

3.2 PREPARATION

3.2.1 Aluminum Subfloor

Surfaces shall be cleaned of grease and dirt. Aluminum plate shall be lightly etched by sand blasting. Contractor shall have the option to use other means of surface preparation, as approved, provided the degree of cleanliness and profile obtained by sand blasting is equaled.

3.2.2 Mixing of Materials

Job mix proportions shall be based on the trial batch proportions used to prepare the floor topping samples submitted and approved. Binder aggregate ratio shall normally range from 1:2 to 1:2.3 (by weight), since mixtures providing satisfactory density, trowelability, and surface texture will be affected by variations in particle shapes, sizes, and size distribution. Three different walnut shell aggregate gradations shall be blended (by weight) as follows: 1 part No. 1; 1.15 parts No. 2; and 1.15 parts No. 3. Minor adjustments of the mix proportions of the approved floor topping samples will be permitted, subject to approval.

Mechanical equipment shall be used for mixing of materials. Rotating replaceable 5- to 16-gallon pail mixers shall be used for blending components A (epoxy resin) and B (curing agent) of epoxy binder.

Rotating paddle-type masonry mortar mixers shall be used for preblending the three sizes and color pigment, if any, of the walnut shell aggregate and addition of the mixed epoxy resin binder. Mixing times shall be as recommended by the materials supplier(s), provided mixing times result in homogeneous mixtures. In case the equipment used does not provide uniform mixtures in the times recommended, adjustment of the mixing times shall be subject to approval. Quantity of material mixed at one time shall be limited to that which can be applied and finished within the working life of the mixtures. Temperature of materials at the time of mixing shall be between 65 and 85 degrees F.

3.2.3 Protection

In addition to the protection of adjacent surfaces during installation, areas used to store and mix materials shall have a protective covering under the materials. After application of the sealer coats, finished flooring shall be protected during the remainder of the construction period. In areas of expected minimum or moderate traffic, floors shall be covered with 70-pound kraft paper, a 30-30-30 waterproof kraft paper, or an approved substitute, with strips taped together and edges secured to prevent roll-up. Vegetable fiberboard, plywood, or other suitable material that will not mar the flooring shall be placed over the paper to protect

areas used as passages by workmen and areas subject to floor damage because of subsequent building operations. Upon completion of construction, the protection shall be removed, flooring cleaned and, where necessary, repaired, resealed, or both, at no additional cost to the Government.

3.3 APPLICATION OF FLOOR TOPPING

Apply each component of resinous flooring system in compliance with manufacturer's directions to produce a uniform monolithic wearing surface of thickness indicated, uninterrupted except at divider strips, sawn joints or other types of joints (if any), indicated or required.

Primer/Broadcast: Primer is mixed and applied to the floor with a squeegee and a nap roller. Quartz silica aggregate is immediately broadcast into the wet primer using manufacturer's specially designed Spraycaster. After cure sweep off excess aggregate.

Conductive Undercoat: Conductive Undercoat is mixed just prior to use in accordance with prescribed directions. It is applied to the floor with a squeegee and nap roller.

Conductive Broadcast: The quartz silica aggregate mixed with the conductive elements is broadcast into the wet undercoat using the manufacturer's specially designed Spraycaster. After cure, sweep off the excess aggregate. Do not vacuum.

Conductive Sealer: Conductive Sealer is mixed and applied using a rubber squeegee and then rolled using a medium nap roller. It is then finish-rolled with a texture roller. After allowing sufficient time for cure, apply the second coat of conductive sealer in the same fashion as the first.

Prepared subfloor surface shall be dry and at a temperature of not less than 60 degrees F when application of the floor topping is initiated. Immediately prior to application of the prime/scratch coat on the prepared surface, dust or other loose particles shall be removed by blowing with compressed air or vacuum cleaned. Air compressor used shall be equipped with an efficient oil-water trap to prevent oil contamination or wetting of surface.

3.4 CURING

Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 24 hours.

Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.

3.5 FIELD QUALITY CONTROL

3.5.1 Repairing

Damaged and unacceptable portions of completed work shall be removed and

replaced with new work to match adjacent surfaces at no additional cost to the Government.

3.6 CLEANING

Surfaces of the new work, and adjacent surfaces soiled as a result of the work, shall be cleaned. Equipment, surplus materials, and rubbish from the work shall be removed from the site.

Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.

-- End of Section --

SECTION 09915

PAINTING

PART 1 GENERAL

1.1 REFERENCES (Not Applicable)

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for Paint Materials as listed in the paragraph entitled, "General," of this section.

SD-13 Certificates

Certificates of Compliance shall be submitted for Paint Materials showing conformance with the referenced standards contained in this section.

SD-14 Samples

Manufacturer's Standard Color Charts shall be submitted for Paint Materials showing the manufacturer's recommended color and finish selections. Three color chip samples shall be submitted for each color and gloss scheduled.

PART 2 PRODUCTS

2.1 GENERAL

The following are products that meet the required performance standards for Concrete Block:

	<u>PITTSBURGH</u>	<u>SHERWIN WILLIAMS</u>	<u>GLIDDEN/ICI</u>
Acrylic resin block filler	16-90	B42W46	Bloxfil 4000-1000
Catalyzed epoxy	97-1	B62Z-100	Devran 724

The following are products that meet the required performance standards for Drywall:

	<u>PITTSBURGH</u>	<u>SHERWIN WILLIAMS</u>	<u>GLIDDEN/ICI</u>
Latex Primer	6-2	B28W200	Prep and Prime 1000
Catalyzed epoxy	97-1	B62Z-100	Devran 724

Ferrous metal shall be primed and painted with the following:

	<u>PITTSBURGH</u>	<u>SHERWIN WILLIAMS</u>	<u>GLIDDEN/ICI</u>
Acrylic resin	6-712	B66WW1	6970
Catalyzed epoxy	97-1	B62Z-100	Devran 724

Wood shall be primed and painted with the following:

Wood Primer	97-1*	B62Z-100	Devran 724 Thin 10%
2nd and 3rd coat	97-1*	B62Z-100	Devran 724

* Thin per manufacturer's recommendation

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and applying his product shall be considered a part of this specification.

Surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. Chipped, peeling, or blistered paint shall be removed and the surface spot-primed. Hard glossy surfaces shall be dulled and roughened to ensure proper adhesion.

3.1.1 Wood

Surfaces shall be clean, dry, smooth, and free from oil, grease, and dirt. Knots shall be sealed with a mixture of equal parts of shellac and alcohol. Nail holes, cracks, and other defects shall be filled with plastic wood or putty. Concealed surfaces shall be back-primed before installation.

3.1.2 Masonry

Surfaces shall be free from dirt, oil, grease, wax, form-release compounds, laitance, and other contaminants. Large cracks, voids, and other major surface imperfections shall be cleared of loose material and filled with mortar.

3.1.3 Plaster and Drywall

Surfaces shall be clean and dry. Cracks and other surface imperfections shall be filled with spackling compound and sanded smooth.

3.2 MIXING AND APPLICATION

Exterior painting shall not be allowed in rainy weather or when rain is imminent. Paints or coatings shall not be applied when the temperature or humidity exceeds the manufacturer's recommendations.

Each coat of material applied shall be free from evidence of poor application. Variations in color, gloss, and texture shall not be acceptable.

Finish coats shall show good hiding characteristics and uniform appearance.

Newly painted surfaces shall be protected from damage.

There shall be at least 2 coats of paint applied in accordance with the manufacturer's instructions.

Each coat shall be applied uniformly at the wet-film thickness as specified by the manufacturer.

Spot-painting to correct damaged surfaces will be allowed only when touch-up area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of application as was used to apply the original material.

3.3 PROTECTION REQUIREMENTS

"WET PAINT" signs shall be posted to indicate newly painted surfaces.

3.4 PAINT SCHEDULE

<u>SURFACE</u>	<u>PRIMER</u>	<u>UNDERCOAT AND FINISH COAT</u>	<u>FINISH COLOR AND SHEEN</u>
Ferrous Metal			
Interior masonry (rough/porous)	Acrylic Resin block filler	Water based catalyzed epoxy	*
Interior masonry (smooth)	Acrylic Resin block filler	Water based catalyzed epoxy	*
Interior plaster	latex primer	Water based catalyzed epoxy	*
Interior drywall	Latex primer	Water based catalyzed epoxy	*

* Colors to be selected from manufacturer's standard color samples.
-- End of Section --

SECTION 13282

LEAD PAINT ABATEMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z9.2 (1979; R 1991) Fundamentals Governing the Design and Operation of Local Exhaust Systems

ANSI Z88.2 (1992) Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926.21 Safety Training and Education

29 CFR 1926.55 Gases, Vapors, Fumes, Dusts, and Mists

29 CFR 1926.59 Hazard Communication

29 CFR 1926.62 Lead Exposure in Construction

29 CFR 1926.65 Hazardous Waste Operations and Emergency Response

29 CFR 1926.103 Respiratory Protection

40 CFR 260 Hazardous Waste Management Systems: General

40 CFR 261 Identification and Listing of Hazardous Waste

40 CFR 262 Generators of Hazardous Waste

40 CFR 263 Transporters of Hazardous Waste

40 CFR 264 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 265 Interim Status Standard for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR 268 Land Disposal Restrictions

40 CFR 745 Lead; Requirements for Lead-Based Paint Activities

1.2.7 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron or larger size particles.

1.2.8 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps.

1.2.9 Lead Based Paint (LBP)

Protective or decorative coating which contains lead.

1.2.10 Lead Control Area

An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.

1.2.11 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:

$$\text{PEL (micrograms/cubic meter of air)} = 400/\text{No. hrs worked per day}$$

1.2.12 Personal Sampling

Sampling of airborne lead concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of six to nine inches and centered at the nose or mouth of an employee.

1.2.13 Physical Boundary

Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

1.3 QUALITY ASSURANCE

1.3.1 Medical Examinations

Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 and 29 CFR 1926.103. The examination will not be required if adequate records show that employees have been examined as required by 29 CFR 1926.62 within the last year.

1.3.1.1 Medical Records

Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.

1.3.1.2 Medical Surveillance

Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

1.3.2 Competent Person (CP) Responsibilities

- a. Certify training as meeting all federal, State, and local requirements.
- b. Review and approve lead based paint removal plan for conformance to the applicable referenced standards.
- c. Continuously inspect lead based paint removal work for conformance with the approved plan.
- d. Perform air and wipe sampling.
- e. Ensure work is performed in strict accordance with specifications at all times.
- f. Control work to prevent hazardous exposure to human beings and to the environment at all times.
- g. Certify the conditions of the work as called for elsewhere in this specification.

1.3.3 Training

Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.

1.3.3.1 Training Certification

Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.

1.3.4 Respiratory Protection Program

- a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every six months thereafter as required by 29 CFR 1926.62.
- b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.

1.3.5 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.3.6 Hazardous Waste Management

The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:

- a. Identification and classification of hazardous wastes associated with the work.
- b. Estimated quantities of wastes to be generated and disposed of.
- c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact. Furnish two copies of State and local hazardous waste permits, manifests and EPA Identification numbers.
- d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.
- e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
- f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.
- g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.
- h. Cost for hazardous waste disposal according to this plan.

1.3.7 Safety and Health Compliance

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding removing, handling, storing, transporting, and disposing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply. The following local and State laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials apply:

- a. OAC Chapter 3701-34
- b. OAC Chapter 3745-27
- c. OAC Chapter 3747-51
- d. ORC TITLE 37 CHAPTER 3734

1.3.8 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the hazardous waste management plan and the lead based paint removal plan, including work procedures and precautions for the removal plan.

1.4 DESCRIPTION OF WORK

All paint within the building shall be considered lead containing paint in excess of 1%. All paint required to be removed for demolition and construction activities shall be removed according to contract drawings and specifications.

Remove square feet lead based paint in flaking condition prior to painting.

Remove lead based paint from structural steel framing members where connections of new framing elements occur.

Remove all paint from immediate work area prior to drilling, welding, sawing, flame cutting, heating, or other activities that can release hazardous particles or vapors.

1.5 SUBMITTALS

Submit the following in accordance with section entitled "Submittal Procedures".

1.5.1 SD-02, Manufacturer's Catalog Data

- a. Vacuum filters
- b. Respirators

1.5.2 SD-06, Instructions

- a. Chemicals and equipment
- b. Materials
- c. Material safety data sheets for all chemicals

1.5.3 SD-08, Statements

- a. Qualifications of CP
- b. Testing laboratory and consultant qualifications
- c. Lead based paint removal plan including CP approval (signature, date, and certification number)
- d. Rental equipment notification
- e. Respiratory protection program
- f. Hazard communication program
- g. EPA approved hazardous waste treatment or disposal facility for lead disposal

h. Hazardous waste management plan

1.5.3.1 Qualifications of CP

Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed in accordance with federal, State, and local laws.

1.5.3.2 Testing Laboratory and Consultant

Submit the name, address, and telephone number of the testing laboratory and consultant selected to perform the sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

1.5.3.3 Lead Based Paint Removal Plan (LBPRP)

Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust concentrations are not reached or exceeded outside of the lead control area. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

1.5.4 SD-09, Reports

a. Sampling results

1.5.4.1 Occupational and Environmental Sampling Results

Submit occupational and environmental sampling results to the Contracting Officer within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.

1.5.5 SD-13, Certificates

a. Vacuum filters

1.5.6 SD-18, Records

a. Completed and signed hazardous waste manifest from treatment or disposal facility

b. Certification of medical examinations

c. Employee training certification

1.6 REMOVAL

1.6.1 Title to Materials

Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with Section 01350, except as specified herein.

1.7 EQUIPMENT

1.7.1 Respirators

Furnish appropriate respirators approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.

1.7.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with proper disposable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Dispose of protective whole body clothing as hazardous waste after completion of the project. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

1.7.3 Rental Equipment Notification

If rental equipment is to be used during lead based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the Contracting Officer.

1.7.4 Vacuum Filters

UL 586 labeled HEPA filters.

1.7.5 Equipment for Government Personnel

Furnish the Contracting Officer with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the Contracting Officer will be provided by the Government.

PART 2 PRODUCTS

2.1 CHEMICALS

Submit applicable Material Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the Contracting Officer.

2.2 MATERIALS

The soluble metal content and the total metal content shall not exceed values which would cause a material to be classified as a hazardous waste.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Notification

Notify the Contracting Officer 20 days prior to the start of any paint removal work.

3.1.2 Lead Control Area Requirements

Establish a lead control area by completely enclosing with containment screens the area or structure where lead based paint removal operations will be performed.

3.1.3 Protection of Existing Work to Remain

Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.

3.1.4 Boundary Requirements

Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.

3.1.5 Furnishings

Furniture and equipment will remain in the building. Protect and cover furnishings.

3.1.6 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area.

3.1.7 Decontamination Shower Facility

Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.

3.1.8 Mechanical Ventilation System

- a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.
- b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed,

constructed, installed, and maintained in accordance with ANSI Z9.2.

- c. Vent local exhaust outside the building only and away from building ventilation intakes.
- d. Use locally exhausted, power actuated, paint removal tools.

3.1.9 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

3.1.10 Warning Signs

Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

3.2 WORK PROCEDURES

Perform removal of lead based paint in accordance with approved lead based paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.

3.2.1 Personnel Exiting Procedures

Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

- a. Vacuum themselves off.
- b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.
- c. Shower.
- d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

3.2.2 Air and Wipe Sampling

Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.

- a. The CP shall be on the job site directing the air and wipe sampling and inspecting the lead based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead based paint removal operation.
- b. Collect personal air samples on employees who are anticipated to

have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least twenty-five percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

- c. Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.
- d. Before any work begins, collect and analyze baseline wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead based paint removal.

3.2.2.1 Air Sampling During Paint Removal Work

Conduct area air sampling daily, on each shift in which lead based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the condition(s) causing the increased levels. Notify the Contracting Officer immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the Contracting Officer. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3.2.3 Lead Based Paint Removal

Manual or power sanding of interior and exterior surfaces is not permitted.

Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.

Avoid flash rusting or other deterioration of the substrate. Provide surface preparations for painting.

Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. Describe this paint removal process in the lead based paint removal plan. Perform manual wet sanding and scraping to the maximum extent feasible.

3.2.3.1 Indoor Lead Paint Removal

Perform manual paint removal in lead control areas using negative pressure enclosures with HEPA filtered exhaust and power actuated locally exhausted paint removal tools. Collect paint residue for disposal in accordance with EPA, State, and local requirements.

3.2.3.2 Outdoor Lead Paint Removal

Perform outdoor LBP removal as indicated in federal, State, and local regulations and in the work plan.

3.2.3.3 Air and Wipe Sampling After Paint Removal

After the visual inspection, collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and outside the work area. Collect wipe samples according to the HUD protocol to determine the lead content of settled dust and dirt in micrograms per square foot of surface area.

3.2.4 Cleanup and Disposal

3.2.4.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

3.2.4.2 Certification

The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air and that the surface wipe sample results collected inside and outside the work area are less than 100 micrograms per square foot on uncarpeted floors, less than 500 micrograms per square foot on interior window sills and less than 800 micrograms per square foot on window troughs; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of lead based paint and dust left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the Contracting Officer's acknowledgement of receipt of the CP certification.

3.2.4.3 Disposal

- a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA and State approved hazardous waste treatment, storage, or disposal facility off Government property.
- b. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.

- c. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.

3.2.5 Disposal Documentation

Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.

3.2.6 Payment for Hazardous Waste

Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Government.

-- End of Section --

SECTION 13930

FIRE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 317 (1992) Manual of Steel Construction,
Volume II, Connections

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A112.18.1M (1996) Plumbing Fixture Fittings

ASME INTERNATIONAL (ASME)

ASME B16.34 (1996) Valves - Flanged, Threaded and
Welding End

ASME B31.1 (1995) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM C 592 (2000) Standard Specification for Mineral
Fiber Blanket Insulation and Blanket-Type
Pipe Insulation (Metal-Mesh Covered)
(Industrial Type)

ASTM C 920 (2001) Standard Specification for
Elastomeric Joint Sealants

ASTM E 814 (2000) Standard Test Method for Fire Tests
of Through-Penetration Fire Stops

FM GLOBAL (FM)

FM P7825 (1990; Supple I, II & III) Approval Guide

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS
INDUSTRY (MSS)

MSS SP-58 (1993) Pipe Hangers and Supports -
Materials, Design and Manufacture

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13 (1994) Installation of Sprinkler Systems

NFPA 13E (1989) Fire Department Operations in
Properties Protected by Sprinkler and
Standpipe Systems

NFPA 14 (1993) the Installation of Standpipe and Hose Systems

NFPA 24 (1992) Standard for the Installation of Private Fire Service Mains and Their Appurtenances

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD 101B (1970) Color Code For Pipelines and For Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 595 (Rev B) Colors Used in Government Procurement

FS FF-S-325 (Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

UNDERWRITERS LABORATORIES (UL)

UL 6 (2000; 12th Ed) UL Standard for Safety for Electrical Rigid Metal Conduit-Steel

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Piping Materials
Valves
Sprinkler Heads
Miscellaneous Materials
Supporting Elements

SD-06 Test Reports

Test reports shall be submitted for the following tests in accordance with the paragraph entitled, "System Testing," of this section.

Pressure Tests

PART 2 PRODUCTS

2.1 GENERAL

Fire-protection system materials and equipment provided under this section shall conform to the requirements of the current Underwriters Laboratories (UL) Directory of Fire Protection Equipment and the Factory Mutual (FM P7825) Approval Guide.

Products with UL label or seal or listing in UL 6, and products with FM label or listed in the FM P7825 Approval Guide are acceptable fire-protection system materials and equipment. Materials and equipment furnished shall be compatible with existing system.

2.2 ABOVEGROUND PIPING MATERIALS

See drawings for piping material specification.

2.3 SUPPORTING ELEMENTS

Piping system components and miscellaneous supporting elements shall be provided, including, but not limited to, building-structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Supporting elements shall be suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces.

Supporting elements shall be FM approved or UL listed and shall conform to ASME B31.1, MSS SP-58, and ASME B16.34.

2.3.1 Building-Structure Attachments

2.3.1.1 Anchor Devices, Concrete and Masonry

Anchor devices shall conform to FS FF-S-325:

Group I: Shield, expansion (lead, bolt, and stud anchors)

Group II: Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2

Group III: Shield, expansion (self drilling tubular expansion shell bolt anchors)

Cast-in floor-mounted equipment-anchor devices shall provide adjustable positions.

Powder-actuated anchoring devices shall not be used to support mechanical-systems components.

2.3.1.2 Beam Clamps

Beam clamps shall be center-loading Types 21, 28, 29, and 30, UL listed, cataloged, and load-rated commercially manufactured products.

Type 20 beam clamps shall be used for pipe 2 inches and under.

Two Type 25 beam clamps shall be used per point of pipe support.

2.3.1.3 C-Clamps

C-clamps may be used to support piping sizes 1-1/2 inches and smaller. C-clamps shall be FM approved and UL listed, with hardened cup-tip setscrew, locknut, and retaining strap. Retaining-strap section shall be not less than 1/8 by 1 inch. Beam-flange thickness to which clamps are attached shall not exceed 0.60 inch.

2.3.1.4 Inserts, Concrete

Concrete inserts shall be constructed in accordance with the requirements of MSS SP-58 for Type 18 or 19 and ASME B16.34. When applied to piping in sizes 2-inch iron pipe size (ips) and larger, and where otherwise required by imposed loads, a 1-foot length of 1/2-inch reinforcing rod shall be inserted and wired through wing slots.

2.3.2 Horizontal-Pipe Attachments

2.3.2.1 Single Pipes

Piping in sizes up to and including 2-inch ips shall be supported by Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.

2.3.2.2 Parallel Fire-Protection Pipes

Trapeze hangers fabricated from approved structural steel shapes, with U-bolts, shall be used when so specified. Structural-steel shapes shall conform to supplementary steel requirements or the support shall be of commercially available, approved proprietary-design rolled steel.

2.3.3 Vertical-Pipe Attachments

Single vertical-pipe attachments shall be Type 8.

2.3.4 Hanger Rods and Fixtures

Only circular solid cross section rod hangers shall be used to connect building structure attachments to pipe-support devices. Pipe, straps, or bars of equivalent strength shall be used for hangers.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.3.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC 317.

2.4 SPRINKLER HEADS

2.4.1 Head Types

Automatic sprinkler heads in finished areas below suspended ceiling shall be pendant type. Heads and escutcheon plates shall be approved for ordinary hazard usage unless otherwise indicated.

Heads in all other locations shall be upright type approved for ordinary hazard unless otherwise indicated.

2.4.2 Temperature Rating

Sprinkler heads shall be rated at 155-165 degrees Fahrenheit, and shall be of the quick response variety, unless otherwise indicated.

2.4.3 Spares

Spares shall be furnished for each type of sprinkler head, complete with appropriate wrench.

2.4.4 Head Protection

Heads shall be protected with paper or plastic bags during painting operations. Protection shall be removed immediately upon finishing painting operations.

Head guards shall be provided wherever mechanical damage could occur. Guard finish shall be red enamel.

2.5 MISCELLANEOUS MATERIALS

2.5.1 Bolting

2.5.2 Elastomer Calk

Polysulfide- or polyurethane-base elastomer-calking material shall be two-component type, conforming to ASTM C 920.

2.5.3 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated, except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall conform to ANSI A112.18.1M.

Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing and one-piece or split-pattern type elsewhere. Escutcheons shall have provisions consisting of internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.5.4 Flashing

2.5.5 Pipe-Thread Compounds

Tetrafluoroethylene tape or other suitable compounds shall be used.

2.6 SYSTEM IDENTIFICATION

A coordinated system of piping and equipment identification shall be provided which includes the following.

2.6.1 Service Labeling

Piping, including that concealed in accessible spaces, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction. Labels or tag designations shall be as follows:

<u>SERVICE</u>	<u>LABEL OR TAG DESIGNATION</u>
Main sprinkler supply	FIRE PROTECTION WATER

Piping shall be labeled and arrowed in accordance with the following:

Each point of entry and exit through walls

Each change in direction

In congested or hidden areas, at each point required to clarify service or indicate hazard

In long straight runs, labels shall be located at a distance visible to each other, but in no case shall the distance between labels exceed 40 feet.

Label lettering shall be 2 inches high. Where the size of pipes is 2-1/2-inch outside diameter and smaller, labels shall be attached to 16-gage aluminum sheet which shall be attached to the pipe with 12-gage galvanized wire. Labels shall be legible from the primary service and operating area.

Labels shall be made of self-sticking plastic film designed for permanent installation. Labels shall have white letters on red background.

Label and valve tag schedule above shall not be construed as defining or limiting the work. All piping systems shall be labeled.

2.7 PAINTING

Equipment of the manufacturer's standard product shall be furnished with the manufacturer's standard finish coat.

Other mechanical equipment shall be furnished with a shop-applied prime paint.

PART 3 EXECUTION

3.1 GENERAL

Installation of system materials and equipment shall be in accordance with the recommendations and provisions of NFPA 13, NFPA 13E, NFPA 14, and NFPA 24. Work shall be performed in the presence of the Construction Management Branch Representative who shall be notified by the Contractor 48 hours in advance of the start of work.

All installation work shall be performed by licensed fire protection sprinkler contractors, licensed for such work in the state where the work is to be performed.

3.2 ABOVEGROUND PIPING-SYSTEMS INSTALLATION

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be not less

than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel shall be arranged to be in line with each other and parallel to the lines of the building.

Load rating for pipe-hanger supports shall be based on all lines filled with water. Deflection per span shall not exceed slope gradient of pipe. Schedule 40 and heavier ferrous pipe supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing. For concentrated loads such as valves, allowable span shall be reduced proportionately.

PIPE SIZE (INCHES)	ROD SIZE (INCHES)	HANGER SPACING FOR
		STEEL PIPE (FEET)
Up to 1	3/8	8
1-1/4	3/8	12
1-1/2	3/8	15
2-1/2 to 3-1/2	3/8	15
5	1/2	15
6	1/2	15
8	1/2	15

Vertical risers shall be supported at the base where possible and at intervals specified. Piping shall be guided for lateral stability as necessary. Clamps shall be placed under fittings wherever possible. Carbon-steel pipe shall be supported at each floor at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

Piping shall be securely supported with allowance for thrust forces and thermal expansion and contraction and shall not be subject to mechanical, chemical, vibrational, or other damage, in conformance with ASME B31.1.

3.3 SOUND STOPPING/ FIRE STOPPING

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings; into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceiling where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts, and large floor and wall openings may be accomplished by packing with properly supported mineral fiber insulation or by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Foam shall be finished with a rasp. Vapor barrier shall be not less than 1/8-inch thickness of vinyl mastic applied to visible and accessible surfaces. Where fire stopping is a consideration, materials used for fire

stop shall be in accordance with ASTM E 814.

3.4 SLEEVES

Sleeves shall be provided where piping passes through roofs, masonry or concrete walls, or floors.

Sleeves passing through steel decks shall be continuously welded or brazed to the deck.

Sleeves extending through floors, roofs, or load-bearing walls, and sleeves through fire barriers shall be continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Other sleeves shall be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve, and additionally shall provide a minimum 3/8-inch clearance. Sleeve shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Space between a pipe and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with mineral fiber conforming to ASTM C 592 wherever the piping passes through firewalls, equipment-room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction-surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction-surface penetration shall be filled with an elastomer calk to a depth of 1/2 inch. Surfaces to be calked shall be oil- and grease-free.

3.5 ESCUTCHEONS

Escutcheons shall be provided at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Where suspended ceilings are installed, plates shall be provided at the underside only of such ceilings. Escutcheons shall be chrome plated in occupied spaces and shall conceal openings in building construction. Escutcheons shall be firmly attached.

3.6 PAINTING

All indoor fire protection piping, valves, and appurtenances, excluding fire department connections, shall receive two coats of enamel, color No. 11105 (red) in accordance with MIL-STD 101B and FED-STD 595.

3.7 SYSTEM TESTING

3.7.1 Test Gages

Test gages, to be acceptable, shall have 4-1/2-inch dials or larger with accuracy of plus or minus 1/2 of 1 percent of full-scale range and dial graduations and pointer width compatible with readability to within one-half of the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer during a test shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 days prior to the test, test gage number, and the project

number.

3.7.2 Test and Acceptable Criteria

Aboveground systems shall have Pressure Tests at 200 psi or at 50 psi in excess of the maximum pressure when the static pressure is excess of 150 psi.

The applied pressure shall be maintained without further addition of test media for not less than 2 hours. See Section 15003 "General Mechanical Provisions" for Hydrostatic Testing.

Dripping or weeping joints shall be repaired.

3.8 CLEANING AND ADJUSTING

At the completion of the work, all parts of the installation shall be thoroughly cleaned. Equipment, pipes, valves, and fittings shall be cleaned of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system. Automatic control devices shall be adjusted for proper operation.

-- End of Section --

SECTION 15003

GENERAL MECHANICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2000) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 82 (1996) Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 2001 (2001) Building Materials Directory

UL 6 (2000; 12th Ed) UL Standard for Safety for Electrical Rigid Metal Conduit-Steel

1.2 SUBMITTALS (Not Applicable)

1.3 APPLICABILITY

This section shall apply to, and be a component part of, each section that is a part of Division 15, "Mechanical".

1.4 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, and services to construct, install, and test the complete mechanical systems and related work, indicated and specified.

1.5 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets as required by vertical and horizontal equipment locations or other job conditions shall be provided to complete the work, at no additional cost to the Government.

Except where shown in dimensional detail, the locations of plumbing, mechanical equipment, ducts, piping, and fittings are only approximate; the exact locations shall be determined by the Contractor, subject to approval by the COTR.

The physical dimensions of equipment indicated are approximate. The Contractor is responsible in verifying that the equipment furnished will fit in the available space. Before installing any equipment, the Contractor shall obtain the exact requirements for the items furnished and shall install plumbing, piping, fittings, supports, and other items of the correct size and shape for the equipment actually installed. Plumbing and piping sizes and equipment ratings shall be taken as a minimum and shall not be reduced without approval.

1.6 CODES AND STANDARDS

Equipment design, fabrication, testing, installation, and system performance shall, unless shown or specified otherwise, comply with the referenced publications to the extent indicated by the references thereto. No equipment or piping, including soldered joints, containing lead shall be installed in potable water systems. No internal fiberglass insulation shall be installed in any air ducts for acoustic or heat flow reduction.

1.7 COORDINATION

Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and ductwork, and all fittings, etc., required to install the work properly shall be furnished complete in place at no additional cost to the Government.

1.8 MECHANICAL SYSTEMS IDENTIFICATION

1.8.1 General

The Contractor shall provide a coordinated system of piping identification which includes:

Piping identification and color coding as per paragraph "Service Labeling".

The Contractor shall submit the entire identification system for approval prior to proceeding with the work.

1.8.2 Service Labeling

All piping and ductwork, including that concealed in accessible spaces; exposed, bare and painted; and insulated, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction and a color warning band. See drawings.

Piping shall be labeled and arrowed in accordance with the following:

Each point of entry and exit of pipe passing through walls

Each change in direction, i.e., elbows, tees

In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other but in no case shall the distance between labels exceed 25 feet. All labels shall be visible and legible from the

primary service and operating area.

The label and system component tag schedule above shall not be construed as defining or limiting the work.

Preprinted legends such as decalcomanias, snap-on, tie-on, or pressure secured are commercially available and shall be used with approval of the COTR. Stapling label to insulation is not permissible. The color band shall be used to secure each end of label. When such legends are used their fabrication and application must be suitable for the environment in which they are used. Background and letter-numerals and color scheme shall match the requirements shown on project drawings.

1.8.3 Asbestos Free Labeling

All newly installed piping and duct insulation shall be labeled to verify that asbestos containing materials do not exist within the insulation. Labels shall be stick-on type with 3 millimeters high white letters on blue background. Stickers shall be formatted as follows:

ASBESTOS FREE

Stickers shall be attached to piping or duct insulation in accordance with the following:

Each point of entry and exit of piping or duct passing through walls or each change in direction, i.e., elbows, tees.

In long, straight runs of pipe or duct, the distance between labels shall not exceed 7.6 meters.

Labels are required in exposed and non-exposed areas.

1.9 APPROVAL REQUIREMENTS

Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data.

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL 2001, and UL 6 will be acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, the Contractor may submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Methods of testing used by the specified agencies shall be outlined.

Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), or other standards, a manufacturer's certificate of compliance of each item will be acceptable as proof of compliance.

Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.10 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

All equipment and materials stored at the site shall be fully protected from damage, dirt, debris, and weather.

All equipment installed with a factory finish shall be fully protected during construction and shall be maintained free of dust, dirt, and foreign matter. All dents and marred finishes shall be repaired or replaced as per the COTR at no additional cost to the Government.

1.11 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations.

1.12 OZONE DEPLETING SUBSTANCES USED AS REFRIGERANTS

Releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's will be minimized by complying with all applicable sections of 40 CFR 82 Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of appliances owned by NASA comply with the following:

No Class I or Class II substances used as a refrigerant may be knowingly vented or otherwise released into the environment.

No appliances may be opened without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices regarding evacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

No work may be conducted on appliances containing refrigerant except by persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification.

In addition, copies of all applicable certifications must be provided to the Contracting Officer at least 10 working days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

Proof of Technician Certification

Proof of Equipment Certification, if recovery or recycling equipment is to be provided by the Contractor

Proof of availability of certified recovery or recycling equipment, if equipment is to be provided by the Contractor

1.13 USE OF OZONE DEPLETING SUBSTANCES, OTHER THAN REFRIGERANTS

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses

include:

Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays

Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial

Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

A waiver may be requested should a programmatic of facility requirement dictate that a prohibited material is necessary to achieve project goals. A waiver request must be submitted in writing to the Test Operations and Institutional Safety Branch. The waiver will be evaluated and dispositioned by a Hazardous Material Review Subcommittee.

1.14 RECORD DRAWINGS AND MANUALS

The Contractor shall provide, and keep up-to-date, a complete record set of drawings which shall be corrected to show every change from the original specification and drawings. Prints for this purpose may be obtained from the COTR. This set of prints shall be kept on the jobsite and shall be used only as a record set. This shall not be construed as authorization for the Contractor to make changes in the layout or specification without approval. Upon completion of the work and before final payment, the record set of drawings and manuals shall be submitted for approval. Upon approval, the record set of drawings and all manuals will be retained by the COTR.

Manuals shall be bound in a loose leaf, 3-ring binder with index tabs separating and identifying equipment. The manual shall contain copies of controls and major equipment and shall be marked to indicate brand and model furnished with capacity data, parts lists, wiring diagrams, operating and maintenance information, and air/water balancing data. Number of copies shall be the same as for submittals or six (6) minimum.

PART 2 PRODUCTS

2.1 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the equipment manufacturer and shall be located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.2 MATERIAL AND EQUIPMENT

Mechanical material and equipment shall meet the requirements indicated and specified and shall be designed for the installation shown. All components

bearing the same part number shall be identical in form, fit, and function.

All materials and equipment shall be new and free from defects. Any metal exposed to the weather shall be fabricated of aluminum or stainless steel (including bolts, nuts, fasteners, supports and ductwork).

2.3 COUPLING AND BELT GUARDS

All rotating equipment with couplings or V-belt drives shall be furnished with an OSHA approved guard.

2.4 PAINTING

All exposed air handling units, piping (not insulated), pneumatic control tubing, control panels, electric conduits for mechanical controls and equipment, and ductwork (not insulated) installed under this contract and exposed to view in finished areas, shall be painted.

All equipment units shall be painted in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouching shall be accomplished only if approved; otherwise equipment shall be returned to the factory for refinishing.

PART 3 EXECUTION

3.1 INSTALLATION

Materials and equipment shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

No installation shall be permitted which blocks or otherwise impedes access to any existing machine or system. All hinged doors shall swing open a minimum of 120 degrees. The area in front of all access doors shall be clear a minimum of 3 feet. The area in front of all access doors to electrical circuits shall be clear the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices) and an additional 3 feet.

Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations. All indicators, to include gauges, meters, and alarms shall be mounted in order to be easily visible by people in the area.

Materials encountered during the installation of piping and/or equipment may be coated with a lead containing paint. Lead paint shall be handled as per specification Section 13282, "Lead Remediation."

Insulation materials installed on piping and ductwork must be dry. Any liquid containing insulation shall be replaced before the vapor barrier is sealed; and, if exposed to outdoor conditions, weather proofing is completed.

3.2 EQUIPMENT PADS

Equipment pads shall be provided and shall be of dimensions shown or, if not shown, they shall conform to the shape of each piece of equipment

served with a minimum 3-inch margin around the equipment and supports and shall be 4-inch thickness. Equipment bases and foundations, when constructed of concrete or grout, shall cure a minimum of 14 days before being loaded. Chamfer top edges of equipment pads.

3.3 PIPE AND DUCTWORK SUPPORTS

Piping and ductwork shall be supported from, or suspended from, the building steel or concrete structure and not from the roof deck.

Pipe, including electric conduits, and ductwork on the roof shall be supported from an 18-gauge galvanized steel prefabricated curb, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer, counterflashing with lag screws, internally reinforced, 45-degree cant base for flashing, 12-inch minimum height, and 12-inch minimum length.

Note the requirements of the paragraph "Material and Equipment" for materials exposed to weather.

3.4 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching of the building structure.

Holes in exposed locations, in or through existing floors, shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved by the Contracting Officer's Technical Representative.

Holes through masonry walls, floors, or ceilings, to accommodate sleeves, shall be made with an iron pipe masonry core saw.

3.5 CLEANING

Exposed surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish painting or are enclosed within the building structure.

After piping has been pressure tested and prior to placing systems in operation, all piping and fittings shall be flushed to remove any dirt, grit, rust, scale, grease, oil, or other materials. Water for flushing will be furnished by the Government; but, flushing shall be accomplished in such a manner as to prevent undue water waste.

Before final acceptance, mechanical equipment, including piping, ducting, and fixtures, shall be clean and free from dirt, grease, and finger marks.

3.6 HYDROSTATIC TESTING

3.6.1 General

These guidelines shall be followed for testing systems, that can be filled with a fluid, designed for liquid, gas, or steam.

These guidelines are based on the requirements of the ASME and ANSI Pressure Vessel and Piping Codes and the NASA GRC Operational Safety Manual. The guidelines shall be followed when conducting a hydrostatic test of pressure vessels and piping systems.

See also Section 15950, Testing, Adjusting and Balancing."

3.6.2 Before Test Requirements

Equipment that is not to be subjected to the pressure test shall be either disconnected from the system or isolated. Valves may be used for this purpose provided the valve is designed for the proposed test pressure. Isolated equipment and piping not being tested shall be vented.

All welded, flanged, threaded, brazed, or soldered joints, and other connections not previously pressure tested, shall not be insulated before testing. They shall be exposed for examination during testing.

Water shall be used as the primary test medium. Test water shall be clean and of such quality as to minimize corrosion of the materials in the system under test. Tests with water shall not be conducted when ambient temperature is below 40-degrees F. The temperature of the water used to apply the test shall not be less than 60-degrees F. or higher than 120-degrees F. If a particular situation warrants, the COTR shall be contacted for approval to use other water temperatures or fluids as the test medium.

Vents shall be provided at all high points to purge any possible air pockets during filling the vessel or piping system. Drain connections shall be provided at low points to remove water at the conclusion of the test.

A calibrated, certified pressure gauge shall be connected to the system to be tested. The range of the gauge shall be at least 1 1/2-times the test pressure, but not greater than 2-times the test pressure. Digital pressure gauges may be used if their accuracy is as good as a calibrated dial pressure gauge.

3.6.3 Test Requirements

Before applying hydrostatic pressure, the test equipment shall be examined to see that it is tight. All low pressure filling lines and other components of the test equipment, that should not be subjected to test pressure, shall be disconnected or isolated.

The system under test shall be isolated from the hydrostatic pump by a hand valve. The calibrated pressure gauge, attached to the system, shall be observed for at least 15-minutes to ensure the leak tightness of the system. Leaking will be indicated by a continuous decrease in the system pressure. Temperature changes in the system shall be monitored to correct pressure changes.

Hydrostatic test results shall be documented on the form under Article "Attachments" entitled "Hydrostatic Testing Report" in this Section. Only one vessel or system shall be documented on one report. Multiple vessels or systems require multiple reports.

The hydrostatic pressure shall be increased gradually until the system is subjected to 50% of the test pressure. At this point, the pressure shall be held for at least 10-minutes, documented on the "Hydrostatic Testing Report" under Article "Attachments" in this Section, and the system checked for leaks and other deficiencies.

After 50% of the test pressure is reached, the system pressure shall be increased in 10% increments. Pressure shall be held for at least 10-minutes at each pressure level, documented on the "Hydrostatic Testing Report" under Article "Attachments" in this Section, and visually inspected for leaks at each step. Continue the test until the full test pressure is applied.

The full test pressure shall be continuously maintained for a minimum of 30-minutes. During this time, the system shall be observed for indications of leakage. The pressure shall be documented on the "Hydrostatic Testing Report."

The hydrostatic test pressure at any point in the piping system shall not be less than 1.5-times the design pressure (see drawings for the required test pressure), but shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, pumps or valves.

Following the application of the full hydrostatic test pressure, the pressure shall be reduced to not less than 67% of the test pressure. A close examination of all welds, flanged, threaded, brazed, and soldered joints shall be made to pinpoint any leakage.

Upon completion of the test, the following "Hydrostatic Testing Report" shall be given to the COTR.

3.7 HYDROSTATIC TESTING REPORT

Location - Bldg. No. _____ Building
Title _____

Tested (vessel/piping)

- _____

Pipe Description:

Hydrostatic Test Parameters:

1 - Vessel or Pipe Size: _____

1 - Testing Date: _____

2 - Wall Thickness: _____

2 - Gauge Calib. Date: _____

3 - Material: _____

3 - Hydro Fluid Temp: _____ deg. F
_____ deg. C

4 - Op. Press: _____ PSIG* _____ kPa*

4 - Test Press: _____ PSIG* _____ kPa*

* As shown on drawing CF _____

**(Test Press. = 1.5 X Oper Press)

SPECIFIC	PER CENT	PRESS	PRESS	PRESSURE HELD	PRESSURE TEST
CHECK	(%) OF TEST	PSIG	kPa	FOR:	WITNESS
VERIFIED	PRESSURE				BY NASA PERSON
POINTS					(INITIALS)
1	50			10 min.	

Location - Bldg. No. _____ Building
 Title _____

Tested (vessel/piping)
 - _____

Pipe Description:

Hydrostatic Test Parameters:

2	60			10 min.	
3	70			10 min.	
4	80			10 min.	
5	90			10 min.	
6	100			30 min.	
7	67			INSPECTION	

Remarks:

Hydrostatic Test Performed By:

Contractor: _____ Contract: NAS3- _____

Performed By: (Name/Title): _____ Date: _____

Other: (Name/Title): _____ Date: _____

NASA Witness: COTR: _____ Date: _____

Inspector: _____ Date: _____

Other: (Name/Title): _____ Date: _____

3.8 DISENFECTION

After pressure tests have been completed and before introducing the disinfection solution, piping to be disinfected shall be flushed with water, for a period of time as designated by the COTR, to remove any entrained dirt.

Potable water piping, including valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water, and tested according to AWWA C651 (1999) Disinfecting Water Mains. Solution shall contain not less than 50 parts per million (ppm) of available chlorine. Solution shall be held for a period of not less than 8 hours, after which time the solution shall contain not less than 10 ppm of available chlorine or the piping shall be disinfected again. After successful disinfection, samples

of water shall then be taken for bacteria count. The samples of water shall be sent to an independent testing lab for the count in accordance with EPA 40 CFR, Chapter 1, Section 141.14. "Maximum microbiological containment level" and the results submitted to the COTR for approval. System shall be re-sterilized until the count is approved by the COTR. Before placing the system into service, the piping shall be flushed with water for a minimum of 2 hours or until the residual chlorine is reduced to less than 1.0 ppm. All testing and flushing shall be the responsibility of the Contractor. Water for disinfection will be furnished by the Government, but disposal shall be the responsibility of the Contractor or directed to the nearest sanitary sewer and this will be determined on a case by case basis.

-- End of Section --

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2001) Manual of Steel Construction Load and Resistance Factor Design

AMERICAN WELDING SOCIETY (AWS)

AWS WHB-2.8 (1991; 8th Ed) Welding Handbook; Volume Two - Welding Processes

ASME INTERNATIONAL (ASME)

ASME A112.19.2M (1998) Vitreous China Plumbing Fixtures Supplement 1-June 2000

ASME B31.3 (2002) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM C 553 (2002) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications

ASTM C 920 (2002) Standard Specification for Elastomeric Joint Sealants

ASTM E 814 (2002) Standard Test Method for Fire Tests of Through-Penetration Fire Stops

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (2002) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (2002) Pipe Hangers and Supports - Selection and Application

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS FF-S-325 (Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

UNDERWRITERS LABORATORIES (UL)

UL 1479

(2003) UL Standard for Safety Fire Tests
of Through-Penetration Fire Stops

1.2 GENERAL REQUIREMENTS

Section 15003 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. A complete list of construction equipment to be used shall be provided.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall be submitted for pipes, valves and specialties showing conformance with the referenced standards contained within this section.

As-Built Drawings
Connection Diagrams

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Pipe and Fittings
Piping Specialties
Valves

Equipment Foundation Data shall be in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports on the following tests shall be submitted in accordance with paragraph entitled, "Piping Installation," of this section.

Hydrostatic Tests
Pneumatic Tests
System Operation Tests

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

See drawings for piping specifications.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Elastomer Calk

Polysulfide- or polyurethane-base elastomer calking material shall be two-component type, conforming to ASTM C 920.

2.2.2 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall conform to ASME A112.19.2M.

Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. All escutcheons shall have provisions consisting of internal spring-tension devices for maintaining a fixed position against a surface.

2.2.3 Pipe Thread Compounds

Tetrafluoroethylene tape not less than 2 to 3 mils thick shall be used in potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Tetrafluoroethylene dispersions and other suitable compounds may be used for all other applications upon approval by the Contracting Officer; however, no lead-containing compounds may be used in potable water systems.

2.3 SUPPORTING ELEMENTS

All necessary piping systems and equipment supporting elements shall be provided, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. All supporting elements shall be suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Supporting elements shall conform to requirements of ASME B31.3, FS FF-S-325, MSS SP-58, and MSS SP-69 except as noted.

Attachments welded to pipe shall be made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Supporting elements exposed to weather shall be hot-dip galvanized or stainless steel. Materials shall be of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Supporting elements in contact with copper tubing shall be electroplated with copper.

Type designations specified herein are based on MSS SP-58 and MSS SP-69. Masonry anchor group-, type-, and style-combination designations shall be

in accordance with FS FF-S-325. Support elements, except for supplementary steel, shall be cataloged, load rated, commercially manufactured products.

2.3.1 Building Structure Attachments

2.3.1.1 Anchor Devices, Concrete and Masonry

Anchor devices shall conform to FS FF-S-325 for the following types:

Group I - shield, expansion (lead, bolt and stud anchors)

Group II - shield, expansion (bolt anchors)

Type 2 - machine bolt expansion shield anchors

Class 2 - open-end expansion shield anchors

Style 1 - single-end expansion shield anchors

Style 2 - double-end expansion shield anchors

Group III - shield, expansion (self-drilling
tubular expansion shell bolt anchors)

Group VIII - anchors, expansion (nondrilling)

Cast-in, floor mounted, equipment anchor devices shall provide adjustable positions.

Powder-actuated anchoring devices shall not be used to support any mechanical systems components.

2.3.1.2 Beam Clamps

Beam clamps shall be center-loading MSS SP-58 Type 20.

[When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, MSS SP-58 Type 19 may be used for piping sizes 2 inches and less. Where more than one rod is used per point of pipe support, rod diameter shall be determined in accordance with referenced standards.]

2.3.1.3 C-Clamps

C-clamps may be used to support piping sizes DN40 and smaller. C-clamps shall be FM approved and UL listed, with hardened cup-tip setscrew, locknut, and retaining strap. Retaining-strap section shall be not less than 3 by 25 millimeter. Beam-flange thickness to which clamps are attached shall not exceed 15 millimeter.

2.3.1.4 Inserts, Concrete

Concrete inserts shall be MSS SP-58 Type 18.

2.3.2 Horizontal Pipe Attachments

2.3.2.1 Single Pipes

Piping in sizes to and including 2-inch ips shall be supported by MSS SP-58 Type 6 solid malleable iron pipe rings, except that split-band-type rings may be used in sizes up to 1-inch ips.

MSS SP-58 Type 1 and Type 6 assemblies shall be used on vapor-sealed insulated piping and shall have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

MSS SP-58 Type 40 shields shall be used on all insulated piping. Area of the supporting surface shall be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges shall be rolled away from the insulation.

Insulated piping without vapor barrier on roll supports shall be provided with MSS SP-58 Type 39 saddles.

2.3.2.2 Parallel Pipes

Trapeze hangers fabricated from structural steel shapes, with U-bolts, shall be used in congested areas and where multiple pipe runs occur. Structural steel shapes shall conform to supplementary steel requirements.

2.3.3 Vertical Pipe Attachments

Vertical pipe attachments shall be MSS SP-58 Type 8.

2.3.4 Hanger Rods and Fixtures

Only circular cross section rod hangers may be used to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength shall be used for hangers only where approved by the Contracting Officer.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.3.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC 325.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Test reports for Hydrostatic Tests, Pneumatic Tests, System Operation Tests shall be provided by the Contractor, in compliance with referenced standards contained within this section.

Piping systems shall be fabricated and installed in accordance with ASME B31.3, MSS SP-69, and AWS WHB-2.8.

Connections between steel piping and copper piping shall be electrically isolated from each other with dielectric couplings (or unions) rated for the service.

Final connections to equipment shall be made with unions provided every 100 feet of straight run. Unions shall be provided in the line downstream of screwed- and welded-end valves.

All pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with specified joint compound and not more than three threads shall show after joint is made up.

Joint compounds shall be applied to the male thread only and care shall be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Piping systems shall be securely supported with due allowance for thrust forces, thermal expansion and contraction, and shall not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

3.2 VALVES

Valves shall be provided in piping mains and all branches and at equipment where indicated and as specified.

Valves shall be provided to permit isolation of branch piping and each equipment item from the balance of the system.

Valves unavoidably located in furred or other normally inaccessible places shall be provided with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.3 SUPPORTING ELEMENTS INSTALLATION

Supporting elements shall be provided in accordance with the referenced codes and standards.

Piping shall be supported from building structure. No piping shall be supported from roof deck or from other pipe.

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there shall be no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

Piping support elements shall be installed at intervals specified hereinafter, at locations not more than 3 feet from the ends of each runout, and not over 1 foot from each change in direction of piping.

Load rating for all pipe-hanger supports shall be based on insulated weight

of lines filled with water and forces imposed. Deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span shall be reduced proportionately:

PIPE SIZE <u>INCHES</u>	ROD SIZE <u>INCHES</u>	STEEL PIPE <u>FEET</u>	COPPER PIPE <u>FEET</u>
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8

Vertical risers shall be supported independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Risers shall be guided for lateral stability. For risers subject to expansion, only one rigid support shall be provided at a point approximately one-third down from the top. Clamps shall be placed under fittings unless otherwise specified. Carbon-steel pipe shall be supported at each floor and at not more than 15-foot intervals for pipe 2 inches and smaller and at not more than 20-foot intervals for pipe 2-1/2 inches and larger.

3.4 PENETRATIONS

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces shall include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings shall be accomplished by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed 120 degrees F, by foaming-in-place with self-extinguishing, 2-pound density polyurethane foam to a depth not less than 6 inches. Foam shall be finished with a rasp. Vapor barrier shall be not less than 1/8-inch thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, only mineral wool shall be used and openings shall also be covered with 16-gage sheet metal.

3.5 SLEEVES

Sleeves shall be provided where piping passes through roofs, masonry, concrete walls and floors.

Sleeves that extend through floors, roofs, load bearing walls, and fire barriers shall be continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. All other sleeves shall be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide a minimum 3/8-inch clearance. Sleeve size shall accommodate mechanical and thermal

motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with a mineral fiber conforming to ASTM C 553 Type V (flexible blanket), (to 1,000 degrees F). This packing shall be provided wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration shall be filled with an elastomer calk to a depth of 1/2 inch. All surfaces to be calked shall be oil- and grease-free.

Through-Penetration fire stop materials and methods shall be in accordance with ASTM E 814 and UL 1479.

3.6 ESCUTCHEONS

Escutcheons shall be provided at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Where suspended ceilings are installed, plates shall be provided at the underside only of such ceilings. For insulated pipes, the plates shall be large enough to fit around the insulation. Escutcheons shall be chrome-plated in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Escutcheons shall be firmly attached with setscrews.

3.7 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Test data shall be clear and readily legible.

-- End of Section --

SECTION 15083

DUCT INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM C 1136	(2000a) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 553	(2002) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 795	(2003) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C 916	(1985; R 2000e1) Standard Specification for Adhesives for Duct Thermal Insulation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(1999) Standard on Types of Building Construction
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1.2 SYSTEM DESCRIPTION

Section 15003, "General Mechanical Provisions," Section 15815, "Low Pressure Ductwork," apply to work specified in this section.

This section pertains to field applied thermal insulation installed on the external surfaces of ducts and plenums.

1.3 PERFORMANCE REQUIREMENTS

Thermal-insulation system materials shall be noncombustible, as defined by NFPA 220. Adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, shall have a maximum flame-spread classification (FSC) of 25 and a smoke-developed classification (SDC) of 50. Flame-contributed classification (FCC) shall be as specified for the application. These maximum values shall be determined in accordance with NFPA 225. Adhesives, coatings, and sealants shall be nonflammable in their wet state.

Adhesives, coatings, and sealants shall have published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Adhesives
Coatings
Thermal-Insulation Materials
Jacketing Materials

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following.

2.1.1 Adhesives

2.1.1.1 Adhesive Vapor Barrier

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, shall be the solvent-base synthetic-rubber type and shall conform to the requirements of ASTM C 916, Type I, for attaching fibrous-glass insulation to metal surfaces. Solvents shall be nonflammable.

2.1.2 Coatings

2.1.2.1 Indoor Vapor-Barrier Finishing

Coatings for indoor vapor-barrier finishing of insulation surfaces shall be pigmented resin and solvent compound and shall conform to ASTM C 1136.

2.1.3 Insulation

Insulation conductances shall be maximum values, as tested at any point, not an average. Insulation conductance found by test to exceed the stipulated maximum shall either be replaced or augmented by an additional thickness to bring it to the required maximum conductance.

Thermal-Insulation Materials shall meet referenced standards within this section.

2.1.3.1 Flexible Blankets

Flexible blankets shall be Type 1 blankets and felts, flexible, resilient for use at temperatures up to 400 degrees F, minimum 16.0 kilogram per cubic meter. Thermal conductivity shall be not greater than 0.25 Btu by inch per square foot per hour per degree F at 75 degrees F. Insulation

shall conform to ASTM C 553.

2.1.4 Vapor Barrier Material

Vapor barrier material shall conform to ASTM C 1136, Type I, low vapor transmission, high puncture resistance for use on insulation for piping, ducts, and equipment, and as indicated.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands, and tapes shall be smoothly and securely pasted down. Adhesives shall be applied on a 100-percent coverage basis. Departure from these requirements shall be a basis for rejection.

Joints shall be tight, with insulation lengths tightly butted against each other. Where lengths are cut, cuts shall be smooth and square and without breakage of end surfaces. Where insulation terminates, ends shall be neatly tapered and effectively sealed or finished. Longitudinal seams of exposed insulation shall be directed away from normal view.

Surfaces shall be clean and free of all oil and grease before insulation adhesives or mastics are applied. Solvent cleaning required to bring metal surfaces to such condition shall be provided.

Insulation shall not impede access to duct covers/doors used for duct cleaning and/or maintenance.

Installation Drawings for duct insulation systems shall be in accordance with the adhesive manufacturer's recommended instructions for application.

3.2 SYSTEM TYPES

3.2.1 Type T-11, Flexible Mineral Fiber with Jacket

Duct insulation at fire dampers shall be provided.

Duct insulation terminating at insulated or uninsulated sheet metal and equipment surfaces, supports, damper fittings, walls, and similar penetration and construction points shall be sealed with outdoor vapor-barrier coating and, where lengths exceeding 24 inches are involved.

Insulation nominal thickness shall be 2 inches.

Pins shall be 12 inches on center placed not more than 2 inches from the duct edges, and there shall be not less than two rows of pins per surface. Pins shall be sealed with exterior vapor-barrier coatings and duct tape. Pinned areas and other surfaces shall be level with adjoining insulated surface. Edges shall be square and straight, without scallops.

Exterior surface of the insulation shall be coated with mastic to thickness recommended by the manufacturer.

For sheetmetal exterior, the installation shall be completed using interlocking seams and corner beads.

-- End of Section --

SECTION 15815

LOW PRESSURE DUCTWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325 (2001) Manual of Steel Construction Load and Resistance Factor Design

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 36/A 36M (2003a) Standard Specification for Carbon Structural Steel

ASTM A 653/A 653M (2003) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A (2002) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1481 (1995; 6th Ed) HVAC Duct Construction Standards - Metal and Flexible

UNDERWRITERS LABORATORIES (UL)

UL 181 (2003) UL Standards for Safety Factory-Made Air Ducts and Air Connectors

UL 555 (2002) UL Standard for Safety Fire Dampers

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall be submitted for low pressure ductwork systems

in accordance with paragraph entitled, "Design Requirements," of this section.

Fabrication Drawings
As-Built Drawings

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Galvanized Steel Ductwork Materials
Flexible Duct Materials
Flexible Connectors
Fire Dampers and Wall Collars
Gravity Backdraft and Relief Dampers
Manual Volume Dampers
Access Doors

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports shall be submitted for low pressure ductwork systems on the following tests in accordance with the paragraph entitled, "Ductwork Leakage Tests" and "Fire Damper Tests," of this section.

Operation Tests
Ductwork Leakage Tests

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be provided for:

Fire Dampers and Wall Collars

1.3 PERFORMANCE REQUIREMENTS

Section 15003 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

1.4 DESIGN REQUIREMENTS

Low-pressure systems shall encompass ductwork and plenums where maximum air velocity is 2,000 feet per minute(fpm) and maximum static pressure is 2 inches water gage (wg), positive or negative.

Rigid fibrous-glass ductwork shall not be used.

Fabrication Drawings shall be submitted for low pressure ductwork systems consisting of fabrication and assembly details to be performed in the factory and in the field. Drawings shall show details of room layout.

As-Built Drawings shall provide current factual information including deviations from, and amendments to the drawings and concealed or visible

changes in the work, for low pressure ductwork systems.

1.5 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

PART 2 PRODUCTS

2.1 GALVANIZED STEEL DUCTWORK MATERIALS

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 653/A 653M, G235.

Sheet metal gages and reinforcement thickness shall conform to SMACNA 1481, except for minimum standards stated herein.

MINIMUM SHEET METAL GAGE

<u>DUCT WIDTH</u> <u>INCHES</u>	<u>GAGE</u>
0 - 12	26
13 - 30	24
31 - 60	22

2.1.1 Duct Hangers

Duct hangers in contact with galvanized duct surfaces shall be galvanized steel painted with inorganic zinc.

2.1.2 Mill-Rolled Reinforcing and Supporting Materials

Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, whenever in contact with sheet metal ducting, shall be galvanized in accordance with ASTM A 123/A 123M.

Equivalent strength, proprietary-design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 FLEXIBLE DUCT MATERIALS

Flexible duct connectors shall be in accordance with UL 181, Class 1 material and shall comply with NFPA 90A.

2.3 MANUAL VOLUME DAMPERS

Volume damper construction shall conform to SMACNA 1481.

Dampers shall be equipped with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment. Where damper rod lengths exceed [30] inches, a regulator shall be provided at each end of damper shaft.

All damper shafts shall have two-end bearings.

2.4 GRAVITY BACKDRAFT AND RELIEF DAMPERS

Frame shall be constructed of not less than 1-1/2- by 4 inch reinforced [16]-gage galvanized carbon steel. Frames and mullions shall be solidly secured in place and sealed with elastomer calking against air bypass.

Maximum blade width shall be [9] inches , and maximum blade length shall be [36] inches. Blade material shall be 16-gage galvanized steel 14-gage 6063 & 5052 alloy aluminum. 18-gage Blades shall be provided with mechanically retained seals and 90-degree limit stops.

Dampers used for relief service shall have blades linked together to open not less than 30 degrees on 0.05 inch wg differential pressure.

Shaft bearings shall be graphite-impregnated nylon.

Counterbalanced dampers shall be equipped with fixed or adjustable counterbalancing weights.

2.5 FIRE DAMPERS AND WALL COLLARS

Fire damper locations shall be in accordance with NFPA 90A.

Fire dampers in ductwork shall be provided at firewall barriers.

Fire dampers shall be constructed and labeled in accordance with UL 555 to provide damper and mounting fire-resistance that equals or exceeds fire-resistance of the construction in which installed. For link loads in excess of [20] pounds, UL-approved quartzoid links shall be provided.

Wall collars shall be constructed in accordance with UL 555.

PART 3 EXECUTION

3.1 INSTALLATION

Sheet metal construction shall be provided in accordance with the SMACNA 1481 and NFPA 90A.

Supplementary steel shall be designed and fabricated in accordance with AISC 325.

Fabrication shall be airtight and shall include necessary reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion, noise, and excessive deflection at specified maximum system air pressure.

Offsets and transformations shall be provided as required to avoid interference with the building construction, piping, or equipment.

Wherever ducts pass through firewalls or through walls or floors dividing conditioned spaces from unconditioned spaces, a flanged segment shall be provided in that surface during surface construction.

Sheet metal surfaces to be painted or surfaces to which adhesives will be applied shall be clean and free of oil, grease, and deleterious substances.

Where interiors of ducting may be viewed through air diffusion devices, the viewed interior shall be sheet metal and shall be painted flat black.

Duct strength shall be adequate to prevent failure under pressure or vacuum created by fast closure of ductwork devices. Leaktight automatic relief devices shall be provided.

Plenum anchorage provisions, sheet metal joints, and other areas shall be made airtight and watertight by calking mating galvanized steel and concrete surfaces with a two-component elastomer.

3.2 RECTANGULAR SHEET METAL DUCTS

Angle iron frames shall be welded at corners and ends, whenever possible. Angle iron reinforcements shall be riveted or welded to ducts not more than [6] inches on center, with not less than two points of attachment. 3 inches

Standard seam joints shall be sealed with an elastomer compound to comply with SMACNA 1481 Seal Class A.

Crossbreaking shall be limited to [4] feet and shall be provided on all ducts [8] inches wide and wider. Bead reinforcement shall be provided in lieu of crossbreaking where panel popping may occur. Where rigid insulation will be applied, crossbreaking is not required.

3.2.1 Longitudinal Duct Seams

Corner seams shall be Pittsburgh lock.

3.2.2 Joints and Gaskets

Companion angle flanges shall be bolted together with [1/4] inch diameter bolts and nuts spaced [6] inches on center. Flanged joints shall be gasketed with chloroprene full-face gaskets [1/8] inchthick, with Shore A 40 durometer hardness. Gaskets shall be one piece and vulcanized at joints.

3.2.3 Flexible Duct Joints

Joints between flexible duct without sheet metal collars and round metal ductwork connections shall be made by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer calk, and by securing with sheet metal screws or binding with a strap clamp.

3.2.4 Square Elbows

Single-vane duct turns shall be provided in accordance with SMACNA 1481, and may be used on ducts 12 inches wide and narrower.

Double-vane duct turns shall be provided in accordance with SMACNA 1481.

3.2.5 Radius Elbows

Radius elbows shall conform to SMACNA 1481. Radius elbows shall have an inside radius equal to the width of the duct. Where installation conditions preclude use of standard elbows, the inside radius may be reduced to a minimum of 0.25 times duct width and turning vanes shall be installed in accordance with the following schedule.

WIDTH OF ELBOWS <u>INCHES</u>	RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH		
	<u>VANE NO. 1</u>	<u>VANE NO. 2</u>	<u>VANE NO. 3</u>
Up to 16	56	--	--
17 to 48	43	73	--
49 and over	37	55	83

Where two elbows are placed together in the same plane in ducts 30 inches wide and larger, the guide vanes shall be continuous through both elbows rather than spaced in accordance with above schedule.

3.2.6 Outlets, Inlets, and Duct Branches

Branches, inlets, and outlets shall be installed so that air turbulence will be reduced to a minimum and air volume properly apportioned. Wherever an air-diffusion device is shown as being installed on the side, top, or bottom of a duct, a commercially manufactured air extractor shall be provided to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

Where a duct branch is to handle more than 25 percent of the air handled by the duct main, a complete 90-degree increasing elbow shall be used with an inside radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct shall have the same ratio to the main duct size as the ratio of the related air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have a 45 degree side take-off entry in accordance with SMACNA 1481 Fig 2-6.

3.2.7 Duct Transitions

Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.2.8 Branch Connections

Radius tap-ins shall be constructed in accordance with SMACNA 1481.

3.2.9 Access Openings

Access doors and panels shall be installed in ductwork adjacent to fire dampers and at controls or at any item requiring periodic inspection, adjustment, maintenance or cleaning.

Minimum size of access opening shall be 12 by 18 inches , unless precluded by duct dimensions or otherwise indicated.

Access door construction shall be in accordance with SMACNA 1481, except

that sliding doors may be used only for special conditions upon prior approval. Insulated doors shall be double-panel type.

Access doors that leak shall be made airtight by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

3.2.10 Duct Supports

Selection of hanging system shall be at the Contractor's option. The following support sizes, configurations, and spacings are given to show the minimal type of supporting component required. Where installed loads are excessive for the specified hanger spacings, hangers, and accessories, heavier-duty components shall be provided and the hanger spacing may be reduced. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member or damage to ducting shall be replaced or the condition shall be alleviated.

Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts and masonry anchors and fasteners shall be approved for the application.

Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be [10] feet with lesser spans for duct assemblies, interferences, and loads imposed or permitted.

There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

Hangers shall be sufficiently cross-braced to eliminate vertical and lateral sway.

Rectangular ducts up to [36] inches shall be supported by strap hangers attached at not less than three places to not less than two duct surfaces in different planes.

Perforated strap hangers shall not be acceptable.

Rectangular ducting, [36] inches and larger, shall be supported by trapeze hangers. Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside of the trapeze. Under no circumstances shall duct hangers penetrate the vapor-sealed facing.

Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

<u>WIDTH OF DUCT, INCHES</u>	<u>MINIMUM BOTTOM ANGLE SIZE, INCHES</u>
30 and smaller	1-1/4 by 1-1/4 by 1/8
31 to 48	1-1/2 by 1-1/2 by 1/8
49 to 72	1-1/2 by 1-1/2 by 3/16

<u>WIDTH OF DUCT, INCHES</u>	<u>MINIMUM BOTTOM ANGLE SIZE, INCHES</u>
73 to 96	2 by 2 by 1/4
97 and larger	3 by 3 by 1/4

Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, such equipment shall be hung independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, and electrical power duct or cable tray shall be considered fully loaded, and supplemental reinforcing or auxiliary support steel to support ductwork shall be provided for these purlins.

3.3 MANUAL VOLUME DAMPERS

Balancing dampers of the splitter, butterfly, or multilouver type, shall be provided to balance each respective main and branch duct.

3.4 FLEXIBLE CONNECTORS FOR SHEET METAL

Air handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

Connectors shall be installed only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkle caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.5 INSULATION PROTECTION ANGLES

Galvanized [20]-gage sheet steel, formed into an angle with a [2] inch exposed long leg with a [3/8] inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness shall be provided.

Angles shall be installed over insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Angles shall be fastened in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Angles shall be installed after final insulation covering has been applied.

3.6 DUCT PROBE ACCESS

Holes shall be provided with neat patches, threaded plugs, or threaded or twist-on caps where indicated, and where necessary, for air-balancing pitot tube access. Extended-neck fittings shall be provided where probe access area is insulated.

3.7 OPENINGS IN ROOFS AND WALLS

Openings indicated in outside walls and roof are approximate.

3.8 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer Technical Representative. Before being assembled, ducting shall be cleaned by wiping down interior of duct with clean cloth.

3.9 FIRE DAMPER TESTS

Operation tests shall be performed on each fire damper in the presence of the Contracting Officer Technical Representative by removing the fusible link and demonstrating the operation of the damper. New links shall be provided and installed after successful testing.

3.10 DUCTWORK LEAKAGE TESTS

Contractor shall conduct leakage test on new duct in accordance with Section 15950 TESTING, ADJUSTING AND BALANCING. Test shall be performed prior to installing ductwork insulation.

3.11 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 15902

CONTROL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASME INTERNATIONAL (ASME)

ASME B16.22 (2002) Wrought Copper and Copper Alloy
Solder Joint Pressure Fittings

ASTM INTERNATIONAL (ASTM)

ASTM B 280 (2003) Standard Specification for Seamless
Copper Tube for Air Conditioning and
Refrigeration Field Service

1.2 GENERAL REQUIREMENTS

Section 15003 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted for control and instrumentation systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

1.3 SYSTEM DESCRIPTION

Automatic temperature control systems shall be complete in all details and shall include all necessary accessories to maintain conditions indicated or specified.

As far as practical, control equipment shall be the product of a single automatic control systems manufacturer. Automatic control systems components not the product of the control system manufacturer shall be approved for use with the control system as indicated.

Automatically controlled valves to control environment shall be furnished by the automatic control systems manufacturer.

Automatically controlled dampers, independent of dampers integral with manufactured air-handling units, shall be furnished by the automatic control systems manufacturer. Damper manufacturer shall be licensed to display the AMCA seal.

Operating Instructions shall be submitted for control and instrumentation consisting of standard operating procedures including startup, shutdown, and emergency operation.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for control and instrumentation systems in accordance with paragraph entitled, "General Requirements," of this section.

Records of Existing Conditions shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Installation Drawings shall be submitted for the following items in accordance with the paragraph entitled, "Installations," of this section. Drawings shall include details of equipment room layout and design.

SD-03 Product Data

Equipment and performance data shall be submitted for the following items consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall also be submitted.

Control Components
Thermometers
Pressure Gages
Valves
Dampers
Operators

SD-04 Samples

Manufacturer's standard color charts shall be submitted for the following items showing the manufacturer's recommended color and finish selections.

Thermostat Covers
Thermostat Guards
Room Humidistats

SD-06 Test Reports

Test reports shall be submitted for controls and instrumentation systems in accordance with the paragraph entitled, "Testing, Calibration, and Acceptance," of this section.

SD-07 Certificates

Listing of Product Installations for controls and instrumentation systems shall be submitted in accordance with paragraph entitled, "Installation," of this section.

SD-08 Manufacturer's Instructions

Operating Instructions shall be submitted for control and instrumentation in accordance with paragraph entitled, "System Description," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be provided for the following items:

Pneumatic Operators

1.5 STORAGE AND HANDLING

Openings shall be sealed after manufacturing and inspection, until ready for installation.

Instruments and equipment shall be carefully handled, shall not be subjected to shock, and shall be protected from weather, dust, construction materials, and damage.

PART 2 PRODUCTS

2.1 CONTROL COMPONENTS

2.2 CONTROL SYSTEM VALVES

Valve bodies, 2 inch iron pipe size (ips) and smaller, shall be bronze with screwed end connections.

Valves shall be single seated for dead-end service except where otherwise indicated.

Modulating service valves shall have plugs matched to the characteristics of the coil for effective control. Valve-stem packing shall be tetrafluoroethylene, spring-loaded, and self-adjusting.

Valve stem shall be top and bottom guided and shall be AISI 303 corrosion-resistant steel. Cage construction is acceptable.

Valves shall be provided with position indicators and, where indicated or required for proper operation, shall be provided with positioners.

Valve linkage shall have an adjustment for valve lift.

2.2.1 Hydronic

Hydronic system valve bodies and trim shall be rated for service pressures through 125 psi at 250 degrees F.

Hydronic system valves shall have replaceable plugs and seats of SAE 72 brass or AISI 303 corrosion-resistant steel, selected for maximum life depending on application conditions.

Maximum pressure drop across any hydronic system valve at maximum flow shall be 5 feet of water.

2.3 CONTROL AND INSTRUMENTATION TUBING

2.3.1 General

Installation of HVAC pneumatic tubing shall be done by qualified control and instrumentation specialists with at least five (5) years of proven expertise in the installation of pneumatic tubing on jobs of comparable magnitude. Installation shall be in accordance with the manufacturer's instructions and as specified herein.

Pipe connections shall be provided in air lines at each pneumatic room controller to connect gages for testing.

2.3.2 Control and Instrumentation Tubing

Copper tubing shall be hard drawn seamless copper, conforming to ASTM B 280.

Fittings shall be solder joint, wrought copper, conforming to ASME B16.22.

Fittings for copper tubing shall be wrought copper solder-joint type except at connection to apparatus where brass mechanical and ips threaded-adaptor fittings shall be used. Tool-made bends in copper tubing shall be acceptable in lieu of fittings. Solder shall be 95-5 tin antimony solder conforming to AWS-02.

Ball-sleeve shall be compression type, rod or forged brass conforming to SAE 72 or 88 UL-approved, with minimum pressure rating of 200 psi at 100 degrees F.

Polyethylene tubing shall be back virgin polyethylene tubing conforming ASTM D 1248. The tubing shall be fire-retardant and low smoke producing, tested in accordance with ASTM D 1693 standards with minimum burst pressure of 4140 kilopascals and a minimum working pressure of 690 kilopascals at 24 degrees C. Multi-tube harness material shall be as specified above, with polyester film barrier and vinyl jacket.

Fittings shall be ball-sleeve compression type, brass or aluminum, with internal sleeves.

2.4 INSTRUMENT AIR SUPPLY

2.4.1 Air Supply Source

Instrument air shall be supplied from a central, dry, compressed-air header, and shall be complete with filter, pressure-reducing valve, pressure-relief valve, upstream and downstream pressure gages, and shutoff and bypass valves.

2.5 CONTROL SYSTEM VALVE AND DAMPER OPERATORS

2.5.1 Operators

Motor operators shall provide smooth proportional control under operating conditions normal to the system.

Spring-return operators shall be provided for two-position control.

Spring returns shall be provided on reversible operators where required for fail-safe operation.

Operators operating in sequence with other operators shall have adjustable operating ranges and set points.

Operators shall have sufficient power on closeoff to provide tight sealing against maximum system pressures.

Operators shall close valves and dampers to fail-safe position indicated.

2.5.2 Dampers

Dampers shall be equipped with operators of sufficient power to control dampers, without flutter or hunting, through the entire operating range at air velocities at least 20 percent greater than maximum design velocity.

2.5.3 Pneumatic Operators

Positioners shall be provided where two or more operators are controlled from the same controller, and where indicated. Positioners shall be mounted directly on the driven device. Feedback from the rod shall be through a pilot spring. Starting point shall be adjustable from 2 to 12 psi. Operating span shall be adjustable from 5 to 13 psi.

2.5.4 Electric Operators

Electric motor operators for modulating control shall be reversible type.

Electric motor operators shall be split-phase type with oil-immersed gear train. Motor shall have ample capacity to handle applied loads under operating conditions normal to the system. Locations where temperatures fall below minimum operating temperature of operator shall be heated.

2.6 CENTRAL CONTROL CABINET

2.6.1 Panel Instrument Tubing

Instrument tubing within panels shall be copper or black polyethylene tubing. Tubing connections at panels shall be made with through-bulkhead-type fittings.

Tubing shall be neatly installed and properly supported. Instruments and accessories mounted on hinged access panels shall have sufficient flexible tubing to allow the door to open at least 135 degrees. Flexible tubing shall be tied into a single cable.

Fittings and joints shall be pressure-tight, and as indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Installation of control components shall be done by qualified control and instrumentation specialists working under the direction of the manufacturer's representative.

3.2 CONTROL- AND INSTRUMENT-AIR TUBING INSTALLATION

Terminal single-lines shall be hard-drawn copper tubing with the last 300 millimeters of length (maximum) to the device being polyethylene tubing.

Tubing shall be mechanically attached to supporting surfaces with mechanical devices such as tubing clamps or ADEL clamps. Supporting adhesives and tie-wraps are not acceptable.

Multiple tube runs shall be neatly supported with properly located multi-tube instrument harness or routed within metallic raceway, electrical metallic tubing (EMT), or rigid nonmetallic conduit.

Tubing shall be purged with dry, oil-free, compressed air to rid the system of impurities generated during joint making and installation, and to remove atmospheric moisture before connecting control instruments.

Any exposed-to-view tubing in finished areas shall be painted to match the surroundings.

All tubing shall be number-coded or color-coded, except local individual room control tubing, for future identification and serving of control system. Tube type indicators shall be used, taped on type indicators are not acceptable.

3.2.1 Copper Tubing

Tubing with mechanical joints shall be cut square and burrs shall be removed. Care shall be exercised not to work-harden copper surfaces. Tube ends shall be cut off or annealed by heating and air cooling in accordance with the manufacturer's instructions.

Copper tubing for solder joints shall be cut square and burrs shall be removed. Inside surfaces of fittings and outside surfaces of tubes in joint area shall be cleaned before assembly of joint. Joint flux, filler material, and heat source shall be applied in accordance with the manufacturer's instructions. Valves in copper piping shall have screwed ends with end adaptors to suit mechanical connections, unless solder jointing is otherwise indicated. Copper joints that fail pressure tests shall be remade with new materials, including pipe or tubing fittings and filler metal.

Copper tubing shall be labeled in accordance with the following:

Each point of entry and exit of tubing through walls, or each change in direction, i.e., elbows, and tees.

In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other; but in no case shall the distance between labels exceed 7.6 meters.

3.2.2 Polyethylene Tubing

All polyethylene tubing shall be provided in continuous lengths without splices from termination to termination.

When polyethylene tubing in enclosed channel is used, the enclosed channel shall be oversized and include 20% additional unused tubes.

Polyethylene tubing connections at panels, boxes, and etc... shall be made with through bulkhead-type fittings. In panels, fasten flexible connections bridging cabinets and doors, neatly along hinge side, and protect against abrasions. Tie and support tubing neatly.

Polyethylene tubing shall be labeled in accordance with the following:

When routed within enclosed channels, tubing shall be identified at all terminations and within all junction boxes through which it is routed.

In long straight runs, enclosed channels shall be identified at distances within eyesight of each other; but, in no case shall the distance between labels exceed 7.6 meters.

3.2.3 Areas of Use

Definitions:

Exposed/concealed accessible-tubing that runs in mechanical equipment rooms, inside mechanical equipment enclosures, such as heating and cooling units, instrument panels, inside pipe chases, suspended ceilings with each access, and etc....

Concealed in-accessible-tubing that runs in concrete slabs, furred walls, or ceilings with no access.

Areas of Use:

In exposed/concealed accessible areas, provide copper tubing with maximum unsupported length of 1 meter. Polyethylene may be used in lieu of copper when run within an enclosed channel, such as a metallic raceway, EMT or rigid nonmetallic conduit. These enclosed channels shall be secured within 1 meter of each junction box or termination. In addition, the metallic raceway and EMT shall be supported at intervals not exceeding 3 meters. The rigid nonmetallic conduit shall be supported as required in the table below:

<u>CONDUIT SIZE (MILLIMETERS)</u>	<u>MAX. SPACING OF SUPPORTS (METERS)</u>
12.5 - 25	1
32 - 50	1.5
63.5 - 76	1.8
89 - 127	2.1
152	2.4

In concealed inaccessible areas, provide copper or polyethylene tubing within an enclosed channel, such as a metallic raceway, EMT, or rigid nonmetallic conduit. These enclosed channels shall be secured within 1 meter of each junction box or termination. In addition, the metallic raceway and EMT shall be supported at intervals not exceeding 3 meters. The rigid nonmetallic conduit shall be supported as required in the above table. When installed in concrete, provide EMT in pour and extend 152 millimeter above floor line; pull tubing through enclosed channel after pour.

3.3 TESTING, CALIBRATION, AND ACCEPTANCE

After completion of control and pneumatic tubing, all control equipment shall be commissioned and adjusted in terms of design, function, systems balance and performance, and shall be made ready for acceptance tests.

Tests for instrument air tubing (2.9 kilopascals) shall be pneumatic unless otherwise specified or approved by the COTR.

System shall be tested at 1-1/4 times maximum design operating system pressure rating of system components, and the applied pressure shall be maintained. The pneumatic system test shall be in strict accordance with the LeRC Safety Manual. If a leak is detected, the Contractor shall repair the leaks and repeat the system test until no leaks are found.

Components that could be damaged by the test procedure shall be removed from piping systems prior to testing. After testing is completed, the Contractor shall reinstall all components and perform a leak test.

3.4 OPERATOR TRAINING

Written operating instructions and not less than 4 hours of operator training shall be provided. This training is in addition to training specified for DDC controls.

Contractor shall provide classroom and field instructions in operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory trained personnel or qualified representative. Contracting Officer shall be given 14 days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor shall be made available to the Contracting Officer.

3.5 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 15950

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE 111 (1998) Practices for Measurement, Testing,
Adjusting, and Balancing of Building
Heating, Ventilation, Air-Conditioning,
and Refrigeration Systems

ASHRAE Gdl3 (1996) Reducing Emission of Halogenated
Refrigerants in Refrigeration and
Air-Conditioning Equipment and Systems

ASME INTERNATIONAL (ASME)

ASME B31.5 (2001) Refrigeration Piping and Heat
Transfer Components

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1 (2002) National Standards for Total System
Balance

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB TABES (1998) Procedural Standards for Testing,
Adjusting and Balancing of Environmental
Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
(SMACNA)

SMACNA 1143 (1985) HVAC Air Duct Leakage Test Manual

SMACNA TAB HVAC SYSTEMS (2002) HVAC Systems - Testing, Adjusting
and Balancing

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330,
"Submittal Procedures," in sufficient detail to show full compliance with
the specification:

SD-03 Product Data

Equipment and Performance Data shall be submitted in accordance

with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test Reports shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Certificates shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Equipment and Performance Data shall be submitted for instruments and equipment to be used during testing.

Test Reports shall be submitted to the Contracting Officer for approval. Six bound copies of the testing, adjusting, and balancing report shall be provided.

Certificates shall be submitted by the Contractor showing independent laboratory certification of test-apparatus calibration data, dated after the award of the contract.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WATER SYSTEM INTEGRITY TESTING

Prior to acceptance of the work, systems shall be tested in the presence of the Contracting Officer.

Tests shall be performed prior to insulation of surfaces, painting, and concealment of work. Systems containing repaired defects shall be retested to original criteria for acceptance, except when waived by the Contracting Officer.

Tests shall be hydrostatic, unless otherwise specified. Water used for testing shall be potable.

Government will supply testing water, but the Contractor shall provide for approved disposal of contaminated water.

Contractor may conduct tests for his own purposes, but the acceptance test shall be conducted as specified herein.

If the test demonstrates that leakage rate exceeds specified limits, the source(s) of leakage shall be determined, defective materials and workmanship shall be repaired or replaced, and the system shall be retested until specified requirements are met.

Other than standard piping flanges, plugs, caps, and valves, only

commercially manufactured expandable-elastomer plugs shall be used for sealing off piping for test purposes. Safe test-pressure rating of any plug used shall be not less than two times the actual test pressure being applied.

Precautions shall be taken to vent the expansive force of compressed air trapped during high-pressure hydrostatic testing to preclude injury and damage.

Contracting Officer may require the removal of system components, such as plugs or caps, to ascertain that the water has reached all parts of the system if purging or vent valves are not provided.

Piping system components, such as valves, shall be checked for functional operation under system test pressure. Components that could sustain damage due to test pressure shall be removed from piping systems prior to hydrostatic testing.

Leaking gasket joints shall be remade with new gaskets. Leaking copper joints shall be remade with new fittings and new tube ends.

Temperature of water used for testing shall not cause condensation on system surfaces.

Test media shall not be added to a system during a test for a period specified or to be determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and shall be for a minimum of 2 hours, with a maximum of 24 hours. Test may be terminated by direction of the Contracting Officer at any time during this period after it has been determined that the permissible leakage rate has not been exceeded.

Test records of piping systems tests shall be prepared and maintained. Records shall show test personnel responsibilities, dates, test gage identification numbers, ambient and test water temperatures, pressure ranges, rate of pressure drop, leakage rates, and other system characteristics.

3.1.1 Test Gages

Test gages shall have a 4-1/2 inch or larger dial, be accurate to plus or minus one-half of 1 percent of full-scale range, and have dial graduations and pointer width compatible with readability and one-half the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer shall have a test pressure position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to use, test gage number, and project number.

3.1.2 Test and Acceptance Criteria

Aboveground water systems shall be tested per project drawing 150 pounds per square inch (psi) and the applied test pressure shall be maintained without further addition of test media for not less than 2 hours. All joints must remain dry.

3.2 AIR-HANDLING DUCTWORK INTEGRITY TESTING

Structural integrity and leakage testing of air-handling ductwork shall be performed by system or by duct mains and branches.

Tests shall be performed prior to insulation of surfaces, painting, or concealment of work. Unless waived by the Contract Officer, systems containing repaired defects shall be retested to original criteria for acceptance.

Pressure Testing shall be performed per SMACNA 1143 except as modified herein.

DUCT PRESSURE-VELOCITY CLASSIFICATION

STATIC PRESSURE CLASS (INCHES)	Type of PRESSURE	Seal CLASS	VELOCITY (fpm)
2	Pos/Neg	C	2500
1	Pos/Neg	C	2500
1/2	Pos/Neg	C	2000

Seal Class A: All seams, joints, and wall penetrations only

3.2.1 Duct Systems 0 To 2 Inches 500 Pascal Pressure

Portions of systems shall be inspected and tested to positive or negative pressures, or both, whichever is normal to the portion of system under test, in accordance with the following:

There are no visible mechanical defects.

There is no audible leakage at any point when area ambient noise is at normal-occupancy level.

No leakage is perceptible to the hand, when placed within 6 inches of a joint.

Measured total system leakage shall not exceed 1 percent of total system cubic feet per minute (cfm) when tested in accordance with "Leak Tests."

3.2.2 Leak Tests

Test apparatus and procedures shall be similar in all respects to those defined in SMACNA TAB HVAC SYSTEMS and SMACNA 1143. Filtered blower inlet and automatic safety relief device shall be provided to protect system. Accuracy of measurement of leakage flow rate shall be certified to be within 1 percent of total system flow.

3.2.2.1 Test Apparatus

Test apparatus shall consist of:

- a. A source of high pressure air - a portable rotary blower or tank type vacuum cleaner.
- b. A flow measuring device usually an orifice assembly consisting of

straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated to its own calibration curve. Pressure and flow readings are usually taken with U-tube manometers.

3.2.2.2 Test Procedures

Test for audible leaks as follows:

- a. Close off and seal openings in the duct section to be tested. Connect the test apparatus to the duct by means of a flexible duct section.
- b. Start the blower with its control damper closed (some small blowers popularly used for testing ducts may damage the duct because they can develop pressures up to 25 inches wg).
- c. Gradually open the inlet damper until the duct pressure reaches 2 inches wg in excess of designed duct operating pressure. Test pressure is read on manometer No. 1. Note that the pressure is indicated by the difference in level between the two legs of the manometer and not by the distance from zero to the reading on one leg only.
- d. Survey joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.

After all audible leaks have been sealed, the remaining leakage should be measured with the test apparatus orifice section as follows:

- a. Start blower and open damper until duct pressure reaches 25 percent in excess of designed duct operating pressure.
- b. Read the pressure differential across the orifice on manometer No. 2. Leakage rate in cfm is read directly from the calibration curve. If leakage does not occur, the pressure differential will be zero.
- c. Total allowable leakage should not exceed 1 percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
- d. If all audible leaks have been corrected, it is unlikely that the measured leakage will exceed one percent of capacity. If it does, the leaks shall be located by careful listening or feeling along the joint.
- e. It should be noted that even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak that shall be corrected.

3.2.3 Test Report Criteria

A test report shall be provided for each system tested, identified by system or section thereof, and containing leak-test curves for apparatus used and data pertinent to acceptance requirements.

3.3 Pressure Testing

Test gages shall have a 6-inch or larger dial with accuracy of plus or minus one half of one percent of full scale range. Dial graduations and pointer width shall be readable within one quarter of one percent of full scale range. Maximum permissible scale range for a given test shall be such that the pointer shall have an indicating position at midpoint of the dial or within the middle third of the scale range.

Certification of accuracy and correction table shall bear a date within 90 calendar days prior to use, test gage number, and project number.

Pressure shall be applied to field installed piping in accordance with ASHRAE Gdl3 and ASME B31.5.

3.4 AIR AND HYDRONIC SYSTEMS TESTING AND ADJUSTMENT

Operational balancing and adjustment of air-handling and hydronic systems shall be performed under the direction of an independent balancing agency whose field representative is a registered professional engineer. All work shall be done in accordance with NEBB TABES, ASHRAE 111, AABC MN-1 or SMACNA TAB HVAC SYSTEMS, where applicable, the requirements of the contract documents, and in the presence of the Contracting Officer.

Operational balancing and adjustment of air-handling and hydronic systems shall be done in accordance with SMACNA TAB HVAC SYSTEMS, the requirements of the contract documents, and in the presence of the Contracting Officer.

Government reserves the right to require recalibration of any or all test apparatus in accordance with the frequency recommended by the component manufacturer, or when reasonable doubt of accuracy exists.

Hydronic systems structural and leakage testing shall be performed in accordance with requirements specified herein under "Water Systems Testing."

Air-handling systems structural and leakage testing shall be performed in accordance with requirements specified herein under "Air-Handling System Testing."

Components of the various air systems shall be adjusted to operate within the design and operating characteristics published by the equipment manufacturer. Government will require the services of an authorized representative of the manufacturer if the Contractor is unable to adjust any equipment.

Equipment shall not be operated until properly lubricated and brought into specified service condition.

Air- and hydronic-system final adjustments shall be permanently marked to be readily restorable if disturbed.

Systems acceptance is predicated upon successful completion of specified work, receipt by the Contracting Officer of certified data summarizing the performance of all systems within design intent, and approval thereof. Data shall be arranged by system and identified by apparatus and item, using standard forms, where possible, and supplementing with reasonable facsimiles, where necessary.

3.4.1 Air-Handling Systems

3.4.1.1 Balancing, Adjustment, and Acceptance Criteria

Final volume conditions for all systems shall be within the following limits:

Primary air delivery: Plus or minus 5 percent of design cfm at design temperature

3.4.1.2 Balancing and Adjustment, Apparatus and Procedures

Balancing and adjustment apparatus and procedures shall be in accordance with SMACNA TAB HVAC SYSTEMS.

Balancing and adjustment apparatus and procedures shall be in accordance with NEBB TABES.

Instrumentation shall be provided to record air movement data, motor kilowatt (kW) input, and power factor. If motor identification plate current value is exceeded, the next size larger motor, starter, and wiring (if necessary) shall be provided.

3.4.1.3 Test Reports

Test reports shall be provided on all systems tested together with test-apparatus data and air-diffusion device flow coefficients, and the following:

Air-handling apparatus data

Exhaust-fan data

Air-diffusion devices data

Duct-traverse data for the following:

Main supply duct

Main exhaust duct

Filter apparatus data, including visual condition, inlet pressure, and differential pressure for each filter installation

Coil data, including visual condition, inlet pressure, and differential pressure for each coil installation

3.4.2 Hydronic Systems

3.4.2.1 System Balancing, Adjustment, and Acceptance Criteria

Systems final flow conditions shall be within the following limits:

Flow station delivery: Plus 5 percent of design liters per second.

3.4.2.2 Test Apparatus and Procedures

Test apparatus shall consist of devices required for hydronic systems flow measuring and balancing including:

Pressure gages and fittings

Dry bulb thermometers

Balancing-cock adjustment wrenches

Differential-pressure gages or manometers

Complete air balance shall have been accomplished before water balance begins.

3.4.2.3 Hydronic Systems Preparation

Hydronic systems shall be prepared in the following manner:

Proper installation of valves and balancing devices shall be verified.

Valves shall be opened to full-open position, including coil-stop valves, bypass valves, and return-line balancing cocks.

Strainer screens shall be removed and cleaned.

Air vents shall be checked at high points to verify proper installation and operation.

Temperature controls shall be set so that coils are on full cooling. Automatic bypass valves at coils and liquid chiller should close. Follow the same procedure when balancing heating coils are set on full heating.

Water temperature shall be checked at inlet side of cooling and heating coils. Note rise or drop of temperature from source.

3.4.3 System and Temperature-Control Adjustment

3.4.3.1 Adjustment and Acceptance Criteria

After balance and adjustment operations have been completed, the system shall be tested as a whole to see that components perform as an integral part of the system and that temperature and conditions are evenly controlled. Corrections and adjustment shall be made as necessary to meet the specified design requirements.

3.5 DRAINAGE AND VENTING SYSTEM TESTING

Drainage and venting system piping shall be tested before the fixtures are installed. Soil and waste piping installed underground shall be tested before backfilling. Testing shall be applied to the system in its entirety or in sections. If the entire system is tested, openings in pipes, except the highest opening, shall be tightly closed and the system shall be filled with water to the point of overflow.

the highest opening of the section under test, shall be tightly plugged and each section shall be filled and tested with not less than a 10-foot head of water. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that each joint or pipe in the system, except the uppermost 10 feet, has been submitted to a test with not less than a 10-foot head of water. Water shall be kept in the system, or the portion under test, for at least 15 minutes before the inspection starts. System shall be tight at all joints.

3.6 TEST REPORTS

Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 15971

DIRECT DIGITAL CONTROL SYSTEM

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions", applies to work specified in this section.

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for the following items consisting of use life, system function flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall also be submitted:

- Microprocessor
- Microprocessor Components
- Control Devices
- Temperature Sensors
- Humidity Sensors
- Interface Components
- Electric/Pneumatic Control Devices
- Pneumatic/Electric Control Devices
- Cabinetry/Enclosures

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

- Microprocessor
- Microprocessor Components
- Control Devices
- Temperature Sensors
- Humidity Sensors
- Interface Components
- Electric/Pneumatic Control Devices
- Pneumatic/Electric Control Devices
- Cabinetry/Enclosures

SD-04 Drawings

CONTROL SCHEMATICS

Schematic drawings, shall be submitted for Control and Instrumentation systems showing the relative location of all

sensors and control output devices, control diagrams, and final terminations.

SD-04 Drawings

Sequence of Operations shall be shown on the Control Diagram drawings.

Submit a complete written Sequence of Operations for all portions of the system to be controlled by the Direct Digital Control System. Sequence of operation to be in English Language and following approximately the written Sequence of Operation as shown on the drawings.

Upon completion of the job any corrections necessary due to field programming changes will be incorporated into this Sequence of Operation and resubmitted as an AS-BUILT copy.

SD-07 Schedules

Submit a list of all input and output points to the microprocessor including port numbers, description and location of the device, and English language character designation for the device with all variables, set points, flags, and alarms.

Material, Equipment, and Fixture Lists shall be submitted for complete system including manufacturers style or catalog numbers, specification and drawing reference numbers, warrantee information, and fabrication site information.

Submit a list of recommended spare parts.

Final submittal of schedule to include all items as noted above with all schedules in AS-BUILT form.

SD-08 Instructions

Operating Instructions shall be submitted for Control and Instrumentation consisting of standard operating procedures and shall include start up, shutdown, programming and software use instructions and emergency operation procedures.

Submit a complete description of the application Programming Language and instructions on how to program or reprogram any portion of the system using an IBM compatible personal computer. Provide full details regarding hardware requirements and associated software releases.

Submit a complete Printout of all software, including all control algorithms, calculations, and entire control sequence. The program print out shall be in English Language source code, and each line shall be annotated with remark describing the action of that line. The remarks may be printed out as part of the program or may be added by hand to a copy of the actual print out.

The Contractor shall provide classroom and Field Instructions in operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor using the manufacturer's factory trained personnel or

qualified representative. The Contracting Officer's Technical Representative (C.O.T.R.) shall be given fourteen calendar days materials belonging to the manufacturer or vendor; e.g., lists, static exhibits, visual aids shall be made available to the C.O.T.R.

SD-09 Reports

Test Reports shall be submitted for the DDC System in accordance with the paragraph entitled, "Testing, Calibration, and Acceptance" of this section.

SD-18 Records

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of the existing conditions.

SD-19 Operation and Maintenance Manuals

The Contractor shall submit 6 copies of the Operation and Maintenance Manuals 14 calendar days prior to final testing the DDC Systems. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 3/8 inch holes and be bound in a 3-ring, loose-leaf binders. Data shall be organized by separate index tabbed sheets, in a loose leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning labels shall be clearly labeled. Equipment catalog cuts shall be clearly marked to indicate the item furnished.

In addition, prior to final approval all Manufacturers Software Packages including floppy disks and package manuals, one back up copy of the software, and two copies of programs incorporating all field changes shall be submitted to the C.O.T.R. All software and programs submitted shall be on floppy disk and compatible with existing Government hardware and software.

1.3 DESCRIPTION OF SYSTEM

The Direct Digital Control (DDC) System, referred to herein shall be a complete and total, "turn key" system incorporating a microprocessor unit with all of its software and hardware components, all portions of the necessary pneumatic control and sensing devices, and all portions of the electrical system including all control and limited power wiring. All necessary hardware, software, electronic, electrical and pneumatic components, training, testing, calibration as defined herein, on the drawings, or the sequence of operation to be considered as part of the "complete system".

The DDC System shall be a fully automated field monitoring and control system capable of performing its assigned control and energy management functions as a stand alone unit. It shall be capable of being incorporated into the Energy Management Control System (EMCS) for communication with or management by the EMCS. See Part 1.3.1.1 for information on existing EMCS. As necessary additional slave units as dictated by the scope of work, sequence of operation, and spare capacity requirements shall be included.

All portions of the "complete" DDC System to be supplied by and to be the responsibility of the Temperature and Controls (TC) Contractor.

1.3.1 Direct Digital Control System

The Direct Digital Control system shall be fully integrated into the existing EMCS as follows:

1.3.2 Existing System

The NASA Glenn EMCS is composed of distributed microprocessor-based field panel configured in four (4) peer-to-peer networks that are supervised by a host computer. The host computer provides database management and operator interface through five (5) PC-based workstations: System vendor is Siemens, Cleveland, Ohio --(216) 447-1343.

1.3.3 Building Network

All new master microprocessors shall be configured as unique node(s) on the existing EMCS peer to peer network. Network transmission shall be RS-485 via twisted shielded cable. All communication hardware, software, database and start-up shall be provided to accomplish seamless integration with the existing EMCS building network including (1) high speed data transfer rates for alarm reporting, report generation, data up-line/down-line loading, two (2) message and alarm buffering, three (3) error detection, correction, and retransmission to guarantee data integrity, and four (4) synchronization of real-time clocks.

1.3.4 Floor Networks

New or existing Master DDC panels shall support up to three (3) local floor-level networks for bi-directional communication with the Master DDC. Each floor network may support a family of Application Specific Controllers (ACSSs) or other point expansion panels. See the sequence of operation for specific configuration requirements.

PART 2 PRODUCTS

2.1 MICROPROCESSOR UNITS

2.1.1 Stand Alone Capability

The master microprocessor shall have the capability to function as a stand alone unit. Each additional slave unit (as and if required) need not have stand alone capability provided that each slave panel is tied to the master panel as a true slave with a hard wired communication and power link.

2.1.2 Communication Capability

Each master microprocessor (and slave unit through the master or as stand alone unit) shall be capable of being interfaced with the existing Government UCS with the addition of communication hardware and all required programming such that the master panel (and all slave panels) can communicate with and be supervised by the UCS.

The microprocessor shall be capable of performing its full control and energy management functions, regardless of the condition of the communication link with the UCS.

2.1.3 Quantity of Microprocessor Units

The TC Contractor shall be responsible for providing the quantity of microprocessor units to satisfy all of the following conditions:

Microprocessor unit(s) must have capacity to fully implement the requirements contained within the specifications for both control and energy management as well as having capacity for memory to accomplish all historical, time clock, and field programmable programs as defined herein.

Microprocessor unit(s) must be capable of fully implementing all portions of the sequence of operations including all sensing, read only, and control output points as defined within the body of the sequence of operation and by the drawing schematics.

Microprocessor unit(s) must have a minimum of 25 additional (spare) capacity based on the required quantity of digital and analog inputs and outputs utilized to completely implement the system. As necessary to complete the spare capacity requirements, an additional slave panel(s) shall be installed including all power and communication links and have battery backup capacity. The system shall have a minimum spare capacity of not less than 8 inputs and 8 outputs.

Regardless of the number of panels indicated on the drawings (or elsewhere), the number provided shall accommodate the above capacity criteria.

2.1.4 Expandability

The DDC System shall be expandable in the future by the installation of additional slave panels. Total system capacity shall be expandable to at least 180 input and 180 output points.

2.1.5 Battery Backup

The microprocessor shall incorporate a battery backup system capable of retaining the programs Random Access Memory (RAM) for all units for not less than 30 hours.

The battery backup shall incorporate an automatic battery charger.

2.1.6 Hand/Off/Auto Capability

Each and every output point of the microprocessor shall have a manual three position switch marked "Hand/Off/Auto" (HOA) which is capable of overriding the microprocessor output signal when in the "hand" or "off" positions. The microprocessor shall be capable of interpreting the HOA switch position

and communicating the position of this switch.

Switching the output signal of any single output point to "Hand" or "Off" shall not affect the signal of any other output point, except as necessary by program function or logic.

All HOA switches shall be contained within the microprocessor cabinet and not be accessible without opening the panel cover.

All HOA switches shall be viewable through a clear plexiglass viewing window in the cabinet cover panel.

All HOA switches shall be coupled with pilot lights (also viewable through the plexiglass window) indicating the position of the HOA switch.

2.1.7 Control Functions

2.1.7.1 Control

Control Algorithms shall be available and resident in the digital system controller to permit Proportional, Integral and Derivative control modes in any combination to meet the needs of the applications. Other control modes such as incremental, floating or two position shall be available to adopt to job needs.

All control shall be performed in a digital manner using the digital signal from the microprocessor based controller converter through electronic circuitry for modulation through transducers to produce the pneumatic signal for actuation of pneumatic actuators.

2.1.7.2 Energy Management

The digital system controller shall be capable of performing all the energy management functions, whether or not required at this time, necessary to reduce energy consumption. These programs shall include but not be limited to:

- Supply air reset using space load demand and outside air temperatures

- Economizer control.

- Time of Day Scheduling

- Optimal start using an adaptive algorithm to prevent the need for manual adjustment of parameters.

- Client tailored programs. The library of routines available in firmware must be capable of generating additional programs as may be required for specific requirements. These should include but not be limited to:

 - Chiller Efficiency

 - Boiler Efficiency

 - Intermediate Seasonal (dead band) Control

 - VAV Fan Matching and Supply Fan Control

 - Trending of Variables

 - Totalizing

Specific program requirements shall be as needed to completely

accomplish the requirements of the sequence of operations as defined on the construction drawings, and to accomplish the requirements of this specification.

2.1.1.8 Historical Data Storage

The microprocessor must be capable of storing all input and output values in its Random Access Memory. For each variable stored the length of time between samples shall be adjustable via software. The microprocessor shall be capable of retaining at least 24 samples of each input/output in its memory. The amount of memory required for storage of historical data shall be in addition to the amount of memory required for other functions defined herein.

2.1.1.9 Off Hour Programming and Override Capability

The microprocessor shall be capable of "off hour" programming both for evening and weekends. The instructions for "off hour" timing are defined in the Sequence of Operation.

As denoted in the Sequence of Operation and on the drawings the microprocessor may be required to respond to several override switches each of which governs its own system and area. The microprocessor shall be programmed to respond to each of those areas independently of other areas. All switches are to be timed out switches with a minimum override time of two hours and a maximum override time of eight hours. Unless otherwise specified, override to be adjustable turn knob.

2.1.1.10 Holiday Programming

The microprocessor shall operate on a "real time" calendar. As such it shall be capable of responding to at least ten pre-programmed holidays including New Years Day, Martin Luther King Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day, and Christmas Day. In addition the microprocessor shall have the capability of having at least six additional "off" days programmed into it and further have the capability of adding these additional days to its "real time" calendar for permanent storage.

2.1.1.11 Field Programmable

The controller shall contain all necessary mathematic, logic, utility functions and all standard energy calculations and control functions in Read Only Memory (ROM) to be available in any combination for field programming the unit. These routines shall include but not be limited to:

Math Routines:

- Basic Algebra
- Binary Logic
- Relational Logic
- Fixed Formulas for Psychometric Calculations

Utility Routines for:

- Process entry and exit
- Variable adjustments and output
- Alarm indication
- Restart

Control Routines for:

- Signal compensation
- Loop control
- Energy conservation
- Timed programming

2.1.12 Calibration Compensation

To maintain long term analog accuracy in the controller sensing circuits, the DDC System shall sense the voltage being supplied to the resistance sensing element and through firmware compensate for power supply changes due to long term drift or drift due to ambient temperature changes at the power supply.

2.1.13 Diagnostics

The DDC System shall contain in its program a self test procedure for checking the indication lights on the digital display, and by means of nondestructive memory, check the computer.

2.1.14 Default Operating Procedure and Alarms

All variables shall be identified as being reliable or unreliable. When a calculation is required to use a value (sensed or calculated), which is being identified as being unreliable, the unreliable data shall flash. The calculation will use a default value programmed into the unit.

All alarms (for example, a fan did not start) and all deviation alarms (for example, temperature out of range of programmed set point) shall send an alarm signal and light a red light. A scan can then identify all alarms conditions and their identifier.

2.1.15 UL Approval

The DDC microprocessor shall be an approved U.L. system, with U.L. listing as a signaling system.

2.2 SOFTWARE

2.2.1 Language

The software shall be written in an easily understood computer language. A sample of the language to be used shall be submitted for approval by the C.O.T.R.

Terminology used shall be in accordance with ASHRAE 85.

2.2.2 Software Accessibility

The software shall be written such that field changes and general accessibility to the microprocessor unit are limited by password protection.

There shall be a minimum of 3 password protected levels, as follows, with the most accessible (least protected) level listed first.

The least protected level shall allow access with "read only" and "print" (if it does not compromise other levels) capability. At this level, through a field connected IBM compatible PC unit (or, if available, through a phone modem), the user shall have the ability to recall program variables and

view them. Further, the user shall have the capability of printing screen and historical data programs previously written and stored in the microprocessor RAM. No other accessibility beyond "read and print" only is requested or desired and any capability beyond this for this level is to be identified in writing for approval.

The next level shall allow all as identified in the first (lowest) level listed above plus the following:

It shall allow access to change variables and set points previously installed in the program and identified in the Sequence of Operation as "adjustable".

It shall allow the user to define and extrapolate historical data parameters.

It shall allow the user to recognize and acknowledge any alarms and flags.

It shall allow the user to make changes to the real time clock and will allow the user to change holiday and off hour scheduling.

It shall allow the user to override the program and enable or disable control input or outputs. NOTE THAT WHEN ANY OF THE PROGRAM INPUT OR OUTPUTS ARE IN THE DISABLE MODE THIS SHALL CLEARLY AND BOLDLY BE RECOGNIZED WHEN READING VARIABLE AND SET POINT VALUES.

The highest level shall allow the user to do all as identified in the first two levels listed above plus the following:

It shall allow the user to enter and modify the program logic and further shall allow the user to incorporate changes into the permanent memory of the microprocessor.

It shall allow the user to assign new passwords and to reject previously assigned passwords.

2.2.3 Software Programming

The software program shall be written to fully implement the Sequence of Operation, as shown on the drawings, and to accommodate all requirements as defined herein.

In addition the software program shall accommodate the following:

The software program shall be written such that changes to variables and setpoints can be made without accessing the program logic statements.

All inputs, outputs, variables, and setpoints shall be referenced throughout the software by an "alphanumeric" designation. This designation shall be consistent as possible in character, shall be as descriptive as possible of the physical device, and as much as possible define the physical location of the device (for example **I.RMSEN.1** could be used to define the Input of the **Room. SENS**or located in microprocessor number 1). Further, these designations shall be consistent between the program statements and all submitted lists, drawings, and schedules. A list of designations shall be submitted to the C.O.T.R. for approval prior to installation in the microprocessor.

All displayed units (historical or point in time data) shall be in standard English units such as Degrees Fahrenheit, Pounds-per-square Inch, Inches-of-Water Column.

Final values for all variables and set points, including alarm ranges, shall be approved by the C.O.T.R. and changes to these variables, up until the time of final acceptance, shall be made at no cost to the Government.

2.2.4 Alarms

2.2.4.1 Preset Alarm Requirements

Alarm values shall be preset for all input points to the microprocessor. If the alarm value is exceeded a flag shall denote the alarm. The flag shall remain denoted until the flag is acknowledged.

2.2.4.2 Future Considerations for Alarms

The following capability, although not currently to be used, shall be resident in the microprocessor unit:

By the future addition of a communication card and phone modem system the microprocessor unit shall be capable of "CALLING", via phone modem the UCS system and communicating to these systems the location, description, and nature of the alarm.

The alarm message to the UCS system shall be repeated every four hours (time adjustable by programming) until the alarm is acknowledged.

2.2.5 Software Loading and Downloading Capability

Approved programs shall be loaded into the microprocessor via owned IBM compatible PC with a floppy disk.

At completion of the job, after all final debugging has occurred, and the program has been proven to be operational the TC Contractor shall provide the Government with two (2) copies of the final program and software to run the program. Copies shall be provided on floppy disks and shall be compatible with government owned hardware and software.

Software shall allow for future downloading and reloading of the program, including all permanent changes made to the program by authorized government personnel, from and into the microprocessor.

2.2.6 Trend Logging

TC Contractor shall demonstrate the use of trend logging for all equipment, alarms, variable, set points, and historical data collected.

2.3 CENTRAL CONTROL CABINET

2.3.1 General

Control cabinet, for housing of control devices such as transducers and read out gages, shall consist of an enclosed wall mounted modular cabinet section. The front face shall be a hinged cover complete with incorporated cabinet type key lock. **NOTE: All locked cabinets to be keyed such that one key is capable of opening all lockable cabinets, including the**

microprocessor cabinet, regardless of quantity used. Four keys shall be provided to the C.O.T.R. at completion of the project.

Control cabinets damaged in shipment shall be replaced. Microprocessor Cabinets shall be replaced entirely including all internal components and boards. Control Device Cabinets shipped with control components installed shall have all components replaced also. Control Device Cabinets shipped without control devices installed can have damaged parts (door, tub, back plates) replaced, however finish requirements must comply to paragraph entitled, "Finish for Control Device Cabinet."

2.3.2 Microprocessor Control Cabinet(s)

Cabinet for the microprocessor shall incorporate all requirements as shown on the drawings and as specified herein. Microprocessor cabinet can be manufacturers standard unit provided that it meets or exceeds all requirements stated herein for "Control Cabinets" and provided that all requirements for switches, visibility of switches, and indicator lighting are also satisfied.

Finish for the microprocessor control cabinet to be manufactures standard provided that this meets or exceeds the Specification for Finish herein. Color shall be manufactures standard.

Color for the Microprocessor cabinet shall be selected by the C.O.T.R..

NOTE: All finish and painting of the microprocessor cabinet shall be done in the manufacturers shop prior to the installation of any components.]

2.3.3 Control Device Cabinet(s)

Control Device Cabinet(s) are cabinets supplied by the Controls Contractor to house devices such as transducers, readout gauges, control air gauges, etc.

Cabinets shall be made of steel or aluminum and shall provide a flat faced, rigid front panel.

Surfaces shall be free of scale, welding slag, and dirt, and shall be flat without waves. Handling during installation shall not distort the cabinet.

Cutouts shall be square with panels to ensure that instruments can be installed level and square. Finished cutouts and holes shall be free of burrs and sharp edges.

Where multiple cabinets are required, cabinets shall be made up of modular or fabricated sections and no individual section shall exceed 36 inches wide by 48 inches high. Cabinet section joints shall be aligned to each other and installed with bottom parallel to the floor. Each cabinet shall be anchored to the wall or floor as required.

Exterior hardware (screws, hinges, latches) shall be a high grade steel with a polished-nickel or chrome plated finish.

Interior hardware (screws, nuts) shall be cadmium plated steel.

Access door shall be provided with hinges, latches, and locks. Use of

right or left side hinges to be as shown on drawings or to fit application if not shown. Cabinet frame shall be reinforced to prevent doors from sagging when open.

NOTE: All locked cabinets to be keyed such that one key is capable of opening all lockable cabinets, including the microprocessor cabinet regardless of quantity used.

2.3.4 Finish for Control Device Cabinet(s)

Cabinet finish shall conform to Section 09800, "Special Coatings", including all General Requirements, Requirements for Surface Preparation, Coating Material Preparation, Application of Coating Materials, and Acceptance Provisions. Product requirements shall conform to Article 2.2 entitled, "Epoxy Coatings," paragraphs 2.2.1, "General," 2.2.4, "Ferrous and Galvanized Metal Surface Coatings," and 2.2.5, "Aluminum Surface Coatings," in Section 09800.

The following additional requirements shall be considered to supplement the above requirements and shall take preference where a conflict exists.

Field touch up of Control Cabinets shall only be done after all internal components have been removed. Covering these components prior to touch up is not acceptable alternative. An alternative for field touch up of doors is to remove the door from the cabinet, cover the cabinet with plastic to prevent construction dust from entering the cabinet, and make necessary touch up to door away from the cabinet.

Exterior color shall be selected by the C.O.T.R. from manufacturers standard colors.

NOTE: All finish and painting of the Control Device Cabinet shall be done in the Control's Contractors shop (or in the field) prior to the installation of any components.]

2.4 SENSORS

2.4.1 General

All electronic sensors shall have characteristics compatible to the device to which they are connected.

All analog sensors shall utilize industry standard signals (4 to 20 milliamps or 0 to 20 volts D.C.) to facilitate future expansion. Sensors based on proprietary equipment **are not** acceptable.

All sensors shall be isolated from environments which could adversely affect their ability to accurately perform their function. For example, thermostats installed on exterior walls shall be thermally isolated from the affect of outdoor conditions.

All sensors shall be placed such that they can accurately measure the conditions of the environment being sampled. If the appropriate location differs from that shown on the drawing, it is the responsibility of the TC Contractor to inform the C.O.T.R. of the suggested location prior to installation of wiring or conduit for the sensor.

2.4.2 Room or Duct Temperature Sensors

Temperature sensor signals shall be directly proportional to the variations in the measured temperature. The linearity shall be within plus or minus 1/2 of 1 percent for a 200 degree F span, and plus or minus 1 percent for a 50 degree F span, throughout the scale range.

2.4.3 Room or Duct Humidity Sensors

Humidity sensor signals shall be directly proportional to the variations in the measured humidity. The linearity shall be within plus or minus 1 percent for the 70 percent humidity span. When the humidity sensor is duct mounted downstream from a cooling coil, the element shall be capable of withstanding a 98 percent relative humidity without loss of calibration.

2.4.4 Temperature Sensors for Water Service

Well type temperature sensors shall have the same degree of accuracy as room type sensors for a given temperature span.

Wells shall be extended into at least 75% of the total depth of the inside diameter of the pipe and shall not impede the flow of fluid in the pipe. Where insulated piping is being installed the sensor shall be furnished with an extension such that the sensor connection is outside the insulation.

Where a question exists the C.O.T.R. is to be contacted for a final decision on well style, depth, and location.

The water temperature sensor shall be inserted in a non-ferrous separable socket well.

2.4.5 Building or Air Handling Unit Static Pressure Transmitter

Building static-pressure controller shall be a double-bell, differential type with temperature compensation. Scale range shall be minus 0.5 to plus 0.5 Inches of Water Gauge (WG), and sensitivity shall be within plus or minus 0.05 Inches WG. The controller shall be supplied with an adjustable setpoint over the full scale range, an adjustable throttling range (proportional band), and electronic output.

Total system accuracy shall not be less than 0.05 Inches WG.

2.4.6 Building or Air Handling Unit Static Pressure Controller

Building static-pressure controller shall be a slack diaphragm type, with an adjustable set point and adjustable throttling range. Controller range shall be 0.01 to 6.0 Inches WG. Throttling range shall be adjustable from 0.02 to 0.05 Inches WG. Output shall be electronic.

2.4.7 Air, Water or Steam Pressure Transmitters

Pressure transmitters shall be the indicating type for gas, liquid, or steam service. Transmitter range shall be selected for system operating characteristics. Output shall be proportional to system pressure and shall be electronic.

Total system accuracy shall not be less than 1/2 percent of the system range.

2.5 CONTROL DEVICES

2.5.1 Transducers

Electric to pneumatic (EP) transducers shall be used on all outputs to pneumatic actuators, positioners, operators, or other pneumatic control devices.

Transducers shall have the capability of linearly converting the microprocessors 4 to 20 milliamp output signal to a 3 to 15 pound pneumatic signal with a 2% accuracy.

Device shall be capable of bleeding the excess pneumatic air pressure on a fall in the electronic signal while maintaining required accuracy.

Each and every transducer shall be fitted with an air service, 1 3/4 inch dial type 0 to 30 pound pressure gauge to sense the transducer output signal. See Section 15902, "Control Systems" for gage product description. Gauge shall be mounted on the transducer.

2.5.2 Pneumatic and Electric System Accessories

The Contractor is responsible for all items in this section as well as all items in Section 15902, "Control Systems" as necessary for a complete and total job. In as much as is possible, all items shall be from a single manufacturer. Refer to the drawings, sequence of operation and Section 15902, "Control Systems", for pneumatic control devices required as part of a complete system.

Pneumatic/electric control devices and equipment necessary for a complete and total system shall include but not be limited to:

- Dampers and Damper Operators
- Control Valves and Valve Operators
- Sensors (pneumatic)
- Panel Mounted Gauges
- Temperature and Pressure Gauges (field mounted)
- High and Low Temperature Sensors and Controllers
- Smoke Detectors
- Air Pressure Reducing Station
- Refrigeration Dryer
- Control Tubing

Contractor is responsible for complete electrical installation as is necessary for a complete and total turn key system. The scope of this work shall include but not be limited to:

Installation of wiring, both control and limited power between microprocessor units, between microprocessor units and control devices, between all electronic sensing units and the microprocessors, all communication wiring, and any direct wiring between field sensing/control units and their respective control devices.

All electrical accessories as defined in Division 16 (such as conduit, electrical boxes) necessary to support the DDC System.

NOTE: REFER TO INSTALLATION, PART 3 OF THIS SECTION, FOR FURTHER DEFINITION OF THE "LIMITED POWER WIRING" REQUIRED OF THE TC CONTRACTOR.

Refer to Division 16, "Electrical," for parts and installation procedures as is necessary for a complete and total job.

The TC Contractor shall coordinate with the Electrical Contractor to finalize who is responsible for power wiring to eliminate duplication of installation, and to insure that all work is included to provide an operational system. Any questions shall be brought to the C.O.T.R. for clarification.

2.6 TRAINING

Upon completion of the installation of the DDC System and after the contractor has proven the system, upgraded all documentation to "As Built" conditions, and complied with all requirements for final submittals, the TC Contractor is to provide a minimum of 24 hours of training for the governments operating and building services people. Training to include but not be limited to:

- Microprocessor Operation
- Control Device Operation
- Field Device Operation and Calibration
- Programming and use of software packages, specifically relative to "Levels of Access" defined herein
- Basic System Troubleshooting

2.7 SERVICE CONTRACT

TC Contractor shall provide a one year service contract including but not limited to a complete checkout of controls, including confirmation of transducer accuracy, system program operation, and calibration of all operator devices and sensors. Service to be provided twice (one-summer and one-winter) per full year following final acceptance. TC Contractor to submit a written report within 30 calendar days of inspection.

PART 3 EXECUTION

3.1 INSTALLATION

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

Installation of the complete DDC System, including all portions of this section, all portions of the pneumatic Section 15902, "Control Systems," and all control and limited power wiring (as defined below) shall be by a single TC Contractor.

All control components shall be done by a qualified control and instrumentation specialist, working under the direction of the manufacturer's representative.

Installation shall conform to the published or written instructions of the manufacturer, except as otherwise specified herein.

Installation of electrical work to be performed by the TC Contractor shall conform to the specifications in Division 16 unless specified differently herein.

Installation of pneumatic control components shall be as specified in

Section 15902, "Control Systems," unless specified differently herein.

3.2 MICROPROCESSOR AND CONTROL DEVICE CABINET INSTALLATION

Microprocessors shall be installed in locations as indicated on the drawings. All portions of the cabinetry including related components and control devices in separate cabinets shall be mounted adjacent to each other.

A minimum of three feet clear space shall be provided in front of the face of the hinged cabinet door. For cabinet installations with doors greater than three feet wide, clear space shall be provided in front of the panel to open the door 105 degrees from a closed position.

Cabinets shall be mounted such that the center of the panel is five feet above finished floor. In no case shall the top of a panel exceed seven ft. above finished floor.

Stacking of panels is prohibited unless specifically shown otherwise on the drawings, or approved by the C.O.T.R..

CONTRACTOR TO COORDINATE THE INSTALLATION OF CONTROL PANELS SUCH THAT ALL BUILDING MATERIAL FINISHES ARE COMPLETE ENOUGH THAT THERE WILL BE NO SPRAY PAINTING IN ROOMS AFTER THE MICROPROCESSOR CONTROL CABINET OR CONTROL DEVICE CABINET (WITH CONTROLS INSTALLED IN CABINET) HAVE BEEN INSTALLED. IF TOUCH UP PAINTING IS REQUIRED AFTER INSTALLATION IT SHALL BE BY BRUSH ONLY OR THE MICROPROCESSOR AND/OR CONTROL CABINET (WITH CONTROLS INSTALLED IN CABINET) SHALL BE REMOVED.

3.3 SOFTWARE

"Approved" software packages shall be entered into the microprocessor in the field and debugged after all necessary components (such as air handlers, room sensors, control components) have been installed and proven operational. Work on portions of the system is allowed where all components of that portion can function as a stand alone system.

Prior to on-line operation a complete demonstration and readout of the computer real time responsibilities of sensing and control shall be demonstrated in the presence of the C.O.T.R. and project managers representative.

3.4 ELECTRICAL AND ELECTRONIC EQUIPMENT INSTALLATION

The following requirements shall supersede any requirements as shown in the Electrical portion of this specification (Division 16).

3.4.1 Limited Power Wiring Requirements

The Contractor is responsible for providing sufficient power to a junction box within six feet of the microprocessor master panel. Appropriate circuit breakers shall be provided by the Electrical Contractor. The exact power requirements are to be determined by the TC Contractor.

The Contractor is responsible for providing a clean and direct ground at the above junction box. By "clean" and "direct" it is meant that one of the following two methods of grounding shall be provided.

Preferred method is a direct ground line to a properly installed ground rod.

Option is a ground wire "Cad-Welded" to a building ground wire which is directly connected to a building ground. Note that it is not acceptable to connect to building steel as a ground source.

Power wiring from junction box (as defined above) to the microprocessor shall include the following:

- Connection devices, including any terminal strips required
- Surge protection devices
- Ground system (see definition below)
- Any and all power wiring between microprocessor and control devices including linking wiring.
- Any and all power wiring necessary for the operation of motorized dampers, control valves, control devices, controlled directly and/or indirectly by the microprocessor.

NOTE: THE TERM "POWER WIRING" USED ABOVE SHALL BE CONSTRUED TO MEAN ALL WIRE, CONDUIT, FITTINGS, JUNCTION BOXES AS IS NECESSARY FOR A COMPLETE AND TOTAL SYSTEM. FURTHER ALL "POWER WIRING" SHALL BE DONE IN FULL COMPLIANCE WITH DIVISION 16 "ELECTRICAL," HEREIN UNLESS SPECIFICALLY EXCEPTED ABOVE.

3.4.2 Control Wiring

Contractor shall be responsible for the complete installation of the entire control wiring package including higher voltage (110 volt thermostat) control wiring.

All control wiring to be as required in division 16 of this specification.

NOTE: THE TERM "CONTROL WIRING" USED ABOVE SHALL BE CONSTRUED TO MEAN ALL WIRE, CONDUIT, FITTINGS, JUNCTION BOXES AS IS NECESSARY FOR A COMPLETE AND TOTAL SYSTEM.

3.4.3 Grounding System

All grounded devices, relative to and including the microprocessor unit shall be individually grounded with a direct tie to the "clean" and "direct" ground line as defined in above paragraph entitled, "Limited Power Wiring Requirements."

The use of grounding terminal strips is permitted provided that each strip is tied directly to the "clean" and "direct" ground line.

NO DAISY CHAIN GROUNDING SHALL BE PERMITTED.

The only exception to the requirements for grounding shall be that grounding done at and by the manufacturer's factory shall be per the manufacturers standards. Note that components assembled by the TC Contractor, whether in his shop or in the field shall not be considered to be factory installed.

All panels including the microprocessor and control device cabinets shall be individually grounded back to the "clean" and "direct" line described above.

3.5 SURGE SUPPRESSION

All surge suppression devices are to be sized, furnished and installed by

the TC Contractor.

All surge suppression devices to be direct grounded to the "clean" and "direct" ground line provided by the Electrical Contractor.

All surge protection devices to be fuse protected at the device.

3.5.1 Surge Suppression for Power Wiring

All power wiring to the microprocessor and control cabinet to be protected by a surge suppression device. Devices to be selected such that they fully protect the microprocessor and all down stream equipment based on the manufacturers recommendation.

Where multiple power line inputs are used with multiple microprocessors or control device cabinets a separate surge protection device will be used for each device.

3.5.2 Surge Suppression for Communication and/or Phone Connection

The surge suppression device for the microprocessor shall be equipped with phone line class surge protection regardless of whether or not a communication card or phone modem system is provided.

If a separate surge protection device is used for the phone, it shall be direct connected to the "clean" and "direct" ground line.

3.6 ELECTRO MAGNETIC FIELD INTERFERENCE

Manufacturer's recommendations are to be followed relative to the placement of microprocessor units, field routing of sensing, control, and communication wiring, and required shielding as necessary to prevent interference from Electro-Magnetic Fields (EMF) inherent in electrical power equipment.

If not specified in the manufacturers literature the following minimum guidelines shall be followed:

No microprocessor, control cabinet, or exposed control wiring shall be placed within 20 feet of an electrical power source (for example, transformer-feed side voltage rating, switch gear, motor) that is operating at higher than 500 volts.

No microprocessor, control cabinet, or exposed control wiring shall be placed within 10 feet of an electrical power source (for example, transformer-feed side voltage rating, switch gear, motor) that is operating between 300 and 500 volts.

No Control wiring, installed in conduit, shall be run within 15 feet of power wiring, not encased in metal conduit, operating above 500 volts.

No control wiring, installed in conduit, shall be run within 7 feet of power wiring, not enclosed in metal conduit, operating between 300 and 500 volts.

No Control wiring, installed in conduit, shall be run within 10 feet of power wiring, encased in metal conduit, operating above 500 volts.

No control wiring, installed in conduit, shall be run within 5 feet of

power wiring, encased in metal conduit, operating between 300 and 500 volts.

Sensing equipment shall follow the same guidelines as noted for the control wiring installed in conduit.

EXCEPTION: AS NECESSARY SENSORS WILL BE ALLOWED CLOSER WHERE THERE FUNCTION DICTATES SUCH. (i.e. Pressure transmitter around filters on air handling units may necessarily be installed inside the minimum distances noted above because of proximity of filters to motor, however every effort should be made to maximize the distance between the sensor and voltage source.)

3.7 INSTALLATION OF PNEUMATIC PORTIONS OF THE COMPLETE SYSTEM

All installation of Pneumatic equipment such as sensors, operators, tubing, etc. are covered in Section 15902, "Control Systems." TC Contractor is instructed to review this section to fully understand the requirements for a complete and total system.

3.8 TESTING, CALIBRATION, AND ACCEPTANCE

After the inspection has been completed, all systems shall be checked for continuity. All control equipment shall be tested and adjusted, relative to design, function, and performance, and shall otherwise be made ready for air handling system acceptance tests. A report showing set points and final adjustments of all equipment and controls shall be submitted to the Government C.O.T.R.

After air handling system acceptance and after systems have operated in normal service for two weeks, The adjustments on all equipment and devices shall be checked and a report submitted indicating all items tested. All items found to be out of order shall be corrected. When all HVAC systems are in specified operating condition and when all other pertinent specification requirements have been met, and when training is complete the Temperature and Control package will be accepted.

Equipment necessary to check the calibration of the control system components shall be provided by the contractor. Components not in calibration shall be corrected or replaced.

3.9 OPERATING INSTRUCTION AND OPERATOR TRAINING

Written operating instructions and not less than 24 hours of operator training shall be provided. Training shall be completed within two weeks of the final test and calibration. Time for training shall be coordinated through the Contracting Officer.

3.10 SPECIAL TOOLS

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

-- End of Section --

SECTION 16003

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M (2000) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

FEDERAL SPECIFICATIONS (FS)

FS W-J-800 (Rev F) Junction Box: Extension, Junction Box; Cover, Junction Box (Steel, Cadmium, or Zinc-Coated)

FEDERAL STANDARDS (FED-STD)

FED-STD 595 (Rev B) Colors Used in Government Procurement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

MILITARY SPECIFICATIONS (MS)

MS MIL-T-704 (Rev K) Treatment and Painting of Material

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z 535 (1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL-05 (1995) Electrical Construction Materials Directory

UL-913 (2002) Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, II, and III Division I, Hazardous (Classified) Locations

1.2 SUBMITTALS (Not Applicable)

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends, offsets, conduit, and supports as required by vertical and horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the field. Door swings shall be verified to ensure that light switches are properly located.

Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.4 CODES AND STANDARDS

Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2 to the extent indicated by the references.

1.5 COORDINATION

Installation of the electrical work shall be coordinated with the work of other trades.

1.6 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), Inc., the label of, or listing with re-examination, in UL-05 will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive

action), and all outdoor installations, refer to Section 09960, "High Performance Coatings.". Aluminum shall not be used in contact with earth or concrete. Dissimilar metals in intimate contact shall be protected by approved fittings, barrier material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations and cadmium-plated in conformance with FS W-J-800 for interior locations.

1.8 HAZARDOUS AREA

Electrical work within any hazardous location shall meet the applicable requirements of NFPA 70, Chapter 5, Articles 500 through 517 and UL-913. The following definitions apply:

Explosionproof: A receptacle, fixture, device, or equipment enclosure that is designed to withstand explosion of a specified liquid, gas, vapor, or dust within the enclosure and to prevent the ignition of a specified gas, vapor, or dust surrounding the enclosure by sparks, flashes, or explosions of the specified liquid, gas, vapor, or dust that may occur within the enclosure. Enclosure shall be capable of operating at an external temperature that will not ignite a surrounding flammable atmosphere.

Hazardous location: An area where ignitable vapors or dust may cause a fire or explosion created by energy emitted from lighting or other electrical equipment or by electrostatic generation.

NFPA 70, Article 500-2 lists chemical atmospheres by groups A, B, C, and D. In addition, although not defined as a hazardous material by the NEC, oxygen concentrations (liquid and gaseous) are considered to provide a hazard because of the increased flammability of materials exposed to oxygen. Therefore, oxygen concentrations shall be classified under Group D.

Intrinsic Safety: Is an explosion protection technique applied to electrical equipment and wiring intended for installation in hazardous locations. The technique is based upon limiting both electrical and thermal energy under normal and abnormal conditions to levels which are incapable of igniting a hazardous mixture which is present in its most easily ignitable concentration.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Identification plates shall be engraved laminated phenolic, with white surface and black core (black lettering on white background). Identification plates 1-1/2 inches high and smaller shall be a minimum of 1/16 inch thick. Plates larger than 1-1/2 inches high shall be a minimum of 1/8 inch thick and shall have all edges beveled 1/32 inch X 45 degrees.

Letters shall be uppercase and lettering shall be centered horizontally and vertically on the identification plate. Letters shall be 1/2 inch 13 millimeters high for switchgear, unit substations, switchboards, panelboards, motor control centers, and distribution transformers. Letters shall be 1/4 inch 6 millimeters high for safety/disconnect switches, drawout circuit breaker compartments, motor control center compartments,

bus duct plug-in devices, and other equipment. The space between lines on multiline plates shall be equal to height of letters.

Identification plates used indoors shall be fastened with appropriate adhesives. Identification plates used outdoors shall be fastened with self-tapping stainless steel screws.

2.2 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

Any equipment with a secondary powered source shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to NEMA Z 535.

2.3 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

2.4 SEISMIC ANCHORAGE

Electrical equipment, except communications, emergency, and standby equipment, shall be anchored to withstand a lateral force of 0.3 times the weight of the equipment.

Communications, emergency, and standby equipment shall be anchored to withstand a lateral force of 0.6 times the weight of the equipment.

The following standard anchoring should be adequate for equipment not classified as communications, emergency, or standby:

Dry transformers - floor-mounted with four anchor bolts

BOLT DIAMETER

Under 150 kVA	-	3/8
150 to 500 kVA	-	1/2
Over 500 kVA	-	5/8

Panels - floor-mounted with four 1/2-inch diameter anchor bolts

2.5 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside in accordance with MS MIL-T-704. Refer to Section 09960, "High Performance Coatings," for requirement for outdoors or in harsh environments..

ITEM	FINISH COLOR
Circuit Breakers	No. 61 gray (FED-STD 595)

ITEM	FINISH COLOR
Substations	No. 61 gray (FED-STD 595)
Switchgear	No. 61 gray (FED-STD 595)
Transformers	No. 61 gray (FED-STD 595)
Safety Switches	Manufacturer's standard
Panelboards	Manufacturer's standard
Electric Heaters	Manufacturer's standard
Motors	Manufacturer's standard
Limit Switches	Manufacturer's standard
Control Components	Manufacturer's standard

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 PAINTING APPLICATION

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted as specified in Section 09915, "Painting," unless otherwise noted. Work shall be left in a neat and clean condition at final completion of the contract.

3.3 IDENTIFICATION PLATE INSTALLATION

Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws. Hand lettering or marking is not acceptable.

3.4 EQUIPMENT PADS

Equipment pads shall be furnished for all floor mounted electrical equipment.

Equipment pads shall be 4 inch above finished floor and shall be constructed with a minimum 4-inch margin around the equipment and supports.

3.5 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.6 DAMAGE TO WORK

Required repairs and replacement of damaged work shall be done as directed

by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.7 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.

Before final acceptance, electrical equipment, including lighting fixtures and glass, shall be clean and free from dirt, grease, and fingermarks.

3.8 FIELD TESTING AND TEST EQUIPMENT

All Field testing specified in Divisions 16 electrical specification shall be made with test equipment specially designed and calibrated for the purpose. Test equipment used shall be calibrated and certified by an approved testing laboratory. Date of last calibration and certification shall not be more than 6 months old at the time of field testing.

-- End of Section --

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z535.1 (2002) Safety Color Code

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480 (1981) Toggle Switches

INTERNATIONAL CODE COUNCIL (ICC)

ICC A117.1 (1998) American National Standards for Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2003) Enclosures for Electric Equipment (1000 Volts Maximum)

NEMA FB 1 (2001) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

NEMA KS 1 (2001) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

NEMA OS 1 (1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA OS 2 (1996) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

NEMA PB 1 (2000) Panelboards

NEMA RN 1 (1998) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA WD 6 (2002) Wiring Devices - Dimensional Requirements

UNDERWRITERS LABORATORIES (UL)

UL 489 (2003; Bulletin Feb 11, 1992; Bulletin Mar 16, 1992) UL Standard for Safety

Molded-Case Circuit Breakers and
Circuit-Breaker Enclosures

UL 6

(2003) UL Standard for Safety for
Electrical Rigid Metal Conduit-Steel

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following:

Conduits, Raceway and Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures
Dry-Type Distribution Transformers

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduits, Raceway and Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures
Dry-Type Distribution Transformers
Spare Parts

SD-06 Test Reports

Continuity and Insulation Resistance Test
Phase-Rotation Tests
Insulation Resistance Test

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted.

1.3 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment

enclosures shall have the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09960 HIGH PERFORMANCE COATINGS. Aluminum shall not be used in contact with earth or concrete and, where connected to dissimilar metal, shall be protected by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.4 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Instructions shall be submitted including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall be in accordance with UL 6 and shall be galvanized by the hot-dip process. Where underground and in corrosive areas, rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1 or shall be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Gaskets shall be solid. Conduit fittings with blank covers shall have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THHN.

Flexible cable shall be Type SO and shall contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

2.3 SPLICES AND CONNECTORS

Splices in AWG No. 8 and smaller shall be made with approved indentor crimp-type connectors and compression tools.

Splices in AWG No. 6 and larger shall be made with indentor crimp-type connectors and compression tools. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall be in accordance with NEMA KS 1, and shall be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so constructed that an external tool must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Switches shall be of the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

Safety color coding for identification of safety switches shall conform to ANSI Z535.1.

2.4.2 Toggle Switches

Toggle switches shall be in accordance with EIA 480, and shall control incandescent, mercury, and fluorescent lighting fixtures and shall be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, single two-position devices rated 20 amperes at 120/277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with NEMA FB 1 and NEMA OS 1 NEMA OS 2 and shall be not less than 1-1/2 inches deep. Pull and junction boxes shall be furnished with screw-fastened covers.

2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Circuit breakers shall be bolted to the bus. Plug-in circuit breakers shall not be acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Panelboards for use on grounded ac systems shall be provided with a full-capacity isolated neutral bus and a separate, isolated grounding bus bonded to the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Enclosure fronts shall have latchable hinged doors.

2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than 10,000 amperes root-mean-square (rms) symmetrical at 208 volts for lighting panels and 22,000 amperes rms symmetrical for power panels, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, will be acceptable. Lamps of the proper type and wattage shall be provided for each fixture.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Crushed or deformed conduit shall not be installed. Trapped conduit runs shall be avoided where possible. Care shall be taken to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clogged conduit shall be cleared of obstructions or shall be replaced.

3.1.1 Rigid Steel Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Conduit elbows larger than 2-1/2 inches shall be long radius.

Conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, shall be provided with a flush coupling when the floor slab is of sufficient thickness. Otherwise, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.2 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall, utilizing a minimum of four 1/4 inch bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 5 feet above floor level, when possible.

3.3 WIRING DEVICES

3.3.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.3.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having 1/4 inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.4 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with ICC A117.1 and as follows:

<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Receptacles in offices	18 inches
Receptacles in corridors	18 inches
Receptacles in shops & laboratories	48 inches
Receptacles in rest rooms	48 inches
Switches for light control	48 inches

3.5 LAMPS AND LIGHTING FIXTURES

New lamps of the proper type and wattage shall be installed in each fixture. Fixtures and supports shall be securely fastened to structural members and shall be installed parallel and perpendicular to major axes of structures.

3.6 PANELBOARDS

Panelboards shall be securely mounted so that the top operating handle does not exceed 72-inches above the finished floor. No equipment shall be mounted within 36 inches of the front of the panel. Directory card information shall be complete and legible.

3.7 DRY-TYPE DISTRIBUTION TRANSFORMERS

Dry-type transformers shall be connected with flexible metallic conduit.

All dry-type transformers shall be mounted on vibration isolators in accordance with Section 15072 VIBRATION ISOLATION FOR AIR CONDITIONING SYSTEMS.

3.8 IDENTIFICATION PLATES AND WARNINGS

Identification plates shall be furnished for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Process control devices and pilot lights shall have identification plates.

Identification plates shall be furnished for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.9 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09920 ARCHITECTURAL PAINTING or Section 09960 HIGH PERFORMANCE COATINGS.

3.10 FIELD TESTING

After the installation is complete wire and cable shall be given a continuity and insulation resistance test. Insulation resistance test shall be with a 1000 - volt insulation test set. Readings shall be recorded after a minimum of 3 minutes and until the reading is constant for 1 minute. Resistance between phase conductors and ground shall be no less than 25 megohms.

Phase-rotation tests shall be conducted on three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be A, B, C left to right, or top to bottom facing the equipment.

Transformers shall be given an insulation resistance test. Resistance between each phase and ground shall be not less than 25 megohms.

Final acceptance will depend upon the satisfactory performance of the equipment under test. No conductor or circuit shall be energized until the installation has been approved by the Contracting Officer. Final test

data shall be provided to the Contracting Officer. Data shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 16145

STANDARD WIRING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1	(1990) Rigid Steel Conduit - Zinc Coated
ANSI C80.3	(1994) Electrical Metallic Tubing - Zinc-Coated
ANSI C80.5	(1994) Rigid Aluminum Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2000) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM D 2301	(1988; R 1993) Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electric Equipment (1000 Volts Maximum)
NEMA FB 1	(1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA KS 1	(1996) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA PR 4	(1983; R 1989) Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type for Industrial Use
NEMA WC 5	(1992; R 1993) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1 (1993) UL Standard for Safety - Flexible Metal Conduit

UL 1581 (1997; 3rd Ed) UL Standard for Safety - Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 20 (1995) UL Standard for Safety General-Use Snap Switches

UL 486C (1997; 3rd Ed) UL Standard for Safety Splicing Wire Connectors

UL 50 (1995; 11th Ed) UL Standard for Safety - Enclosures for Electrical Equipment

UL 514A (1996; 9th Ed) UL Standard for Safety - Metallic Outlet Boxes

UL 514B (1996; 3rd Ed) UL Standard for Safety Fittings for Conduit and Outlet Boxes

UL 6 (2000; 12th Ed) UL Standard for Safety for Electrical Rigid Metal Conduit-Steel

UL 797 (1993; 6th Ed) UL Standard for Safety - Electrical Metallic Tubing

UL 884 (1994; 9th Ed) UL Standard for Safety Underfloor Raceways and Fittings

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Conduit, Raceways and Fittings G
Wire and Cable G

Safety Switches G
Flush Wiring Devices G
Boxes and Fittings G
Communication Cabinets G

SD-02 Shop Drawings

The following types of drawings shall be submitted to check for contract conformity:

Fabrication Drawings
Assembly Drawings

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduit, Raceways and Fittings G
Wire and Cable G
Safety Switches G
Flush Wiring Devices G
Boxes and Fittings G
Communication Cabinets G

SD-06 Test Reports

Test Reports shall be submitted for standard wiring systems in accordance with the paragraph entitled, "Field Testing," of this section.

1.4 FABRICATION AND ASSEMBLY DRAWINGS

Fabrication Drawings shall be submitted for the standard wiring systems consisting of fabrication and Assembly Drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements for the contract documents.

PART 2 PRODUCTS

2.1 CONDUIT, RACEWAYS AND FITTINGS

Conduit shall be 3/4-inch diameter minimum, except where specifically shown smaller on the contract drawings, and except for exposed switch leg runs.

Conduit, connectors, and fittings shall be approved for the installation of electrical conductors.

2.1.1 Rigid Steel Conduit

Rigid steel conduit, including couplings, elbows, bends, and nipples, shall conform to the requirements of UL 6 and ANSI C80.1 ANSI C80.5 Steel fittings shall be galvanized by the hot-dip process.

Fittings for rigid steel conduit shall be threaded and shall conform to NEMA FB 1.

Conduit fittings with blank covers shall have gaskets except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Gaskets shall be solid for fittings sized 1-1/2 inches and less.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and shall conform to ANSI C80.3 and the requirements of UL 797.

Couplings and connectors shall be hex-nut expansion-gland type, zinc-plated. Crimp, spring, or setscrew (for less than 2") type fittings are not acceptable. Where EMT enters outlet boxes, cabinets, or other enclosures, connectors shall be the insulated-throat type, with a locknut. Fittings shall meet the requirements of NEMA FB 1.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall meet the requirements of UL 1.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for flexible metallic conduit shall meet the requirements of UL 514B, Type I box connector, electrical, Type III coupling, electrical conduit, flexible steel, or Type IV adapter, electrical conduit.

Fittings for liquidtight flexible metallic conduit shall meet the requirements of UL 514B, Type I box connector, electrical, Class 3 liquidtight flexible metallic conduit connectors.

2.1.4 Underfloor Raceways

Underfloor raceways shall conform to UL 884 and NFPA 70.

2.2 WIRE AND CABLE

Insulated current-carrying wire and grounding conductors shall be copper and shall conform to NFPA 70 and UL 1581. Wire bundles with cable ties shall be secured to the enclosure. Self-sticking adhesive attachments are not acceptable.

2.2.1 Building Wire

Building wire for use in conduits, raceways, and wireways shall be single-conductor, 600-volt, heat- and moisture-resistant insulated wire suitable for use in wet or dry locations.

Conductors shall be standard concentric stranded copper wire. Conductors shall be not less than AWG No. 12, except when used for control wiring.

Building wire shall be Type THHN with insulation of PVC and nylon jacket, with a minimum temperature rating of 90 degrees C.

In wet locations building wire shall be Type THWN with insulation of PVC and nylon jacket, with a minimum temperature rating of 75 degrees C.

2.2.2 Standard Flexible Cable

Flexible multiconductor cable shall conform to UL 1581 for control and power below 600 volts, noninstrumentation type. Cable shall contain one (green) grounding conductor and shall utilize a thermosetting or thermoplastic heavy duty (SJO,STO,SO & SJ) overall jacket in accordance with NEMA WC 5. A white conductor shall be included for the power neutral or grounded current-carrying conductor. Cable conductor insulation shall conform to NEMA WC 5.

2.2.3 Splices and Connectors

Splices in building wire AWG No. 8 and smaller and multiple conductor cables shall be made with insulated Scotchlock, or equal, connectors or with indentor crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Splices in building wire AWG No. 6 and larger and single-conductor cables shall be made with indentor crimp-type connectors and compression tools or with bolted clamp-type connectors to ensure a satisfactory mechanical and electrical joint.

Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor. Splices in rubber-insulated neoprene-jacketed wire and cables shall be watertight.

Vinyl-plastic electrical insulating tape shall meet the requirements of ASTM D 2301. Where pressure-sensitive tape is used, the surface shall be cleaned free of dust, sand, or other foreign material and a primer recommended by the tape manufacturer shall be applied prior to taping.

Where indicated, building wire terminations shall utilize screw-set pressure, ring or fork type terminal lugs.

Solid wiring shall be terminated with terminal blocks specifically designed for solid wire. Crimp type shall not be used on solid wire for termination.

Stranded wire shall use crimp type lugs for termination on terminal blocks.

2.3 SAFETY SWITCHES

Switches shall comply with NEMA KS 1.

Safety switches shall be the heavy-duty type with voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so constructed that an external tool (screwdriver) must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch handle shall not be capable of being locked in the ON position.

Switches shall be the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

Safety switches installed outside shall be stainless steel.

2.4 FLUSH WIRING DEVICES

2.4.1 Wall Switches

Toggle switches shall be heavy-duty, general-purpose, noninterchangeable flush devices conforming to UL 20 and NEMA WD 1, as indicated.

Toggle switches as indicated on drawings shall be: single-pole, devices rated 20 amperes at 120/277 volts, 60 hertz, ac only, meeting the requirements of UL 20.

All toggle switches shall be made by the same manufacturer.

2.4.2 Receptacles

Receptacles shall be 20-ampere, 125-volt ac, 2-pole, 3-wire, single or duplex grounded, conforming to NEMA PR 4, NEMA WD 1 and to the 5-20R configuration in NEMA WD 6.

Bodies of 20-ampere receptacles shall be phenolic or nylon (impact resistant) compound supported by a mounting yoke having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Each receptacle shall be side-wired with two screws per terminal, shall be provided with a third grounding pole, and shall be capable of receiving 2-wire, 3-pole parallel-blade caps. Third grounding pole shall be connected to a metal mounting yoke and shall be provided with a green-colored screw for grounding.

Power outlets for connection to 208 volt, three-phase, ac circuits shall consist of single locking receptacles in industrial cast-metal enclosures with cast-aluminum bodies, angle adapters, and receptacle housings with spring-loaded hinged lift covers, conforming to NEMA 250 for the indicated voltage and current rating. Springs and hinge pins shall be corrosion-resistant steel. Screws and spring covers shall be cadmium-plated brass. Gaskets shall provide a positive seal against the entrance of dust, lint, fibers, and oil or coolant seepage.

Locking receptacles shall conform to NEMA WD 6. One plug shall be furnished with each locking receptacle.

Receptacles shall meet the requirements for retention of plugs, overload, temperature, and assembly security in accordance with NEMA WD 1.

2.4.3 Floor Outlets

Convenience outlets installed in floors for connection to 120-volt ac single-phase circuits shall consist of single or duplex receptacles enclosed in floor boxes with cover plates especially approved for this purpose.

2.4.4 Device Plates

Wall plates for flush toggle switches and receptacles shall be the appropriate type and size and shall match the wiring devices for which they are intended. Dimensions for openings in wall plates shall be in accordance with NEMA WD 1.

Wall plates for flush toggle switches and receptacles shall be molded ivory-colored phenolic compounds, with rounded or beveled edges. Mounting

screws shall have oval countersunk heads finished to match the plate.

2.5 BOXES AND FITTINGS

Boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70 and UL 514A.

2.5.1 Sheet Metal Boxes and Outlets

Outlet, switch, and junction boxes flush-mounted in walls or ceilings shall be octagon, square or rectangular -shaped gang boxes as appropriate, with extension rings and covers.

Ceiling outlet boxes, from which surface- and pendant-mounted lighting fixtures are supported, shall be not less than 4 inches octagonal or square, with plaster rings 1-1/2 inches deep and shall be capable of withstanding a vertical downward force of 200 pounds for 5 minutes. All boxes in spaces above suspended ceilings shall be installed in accessible locations. Ceiling-mounted outlet boxes for lighting fixtures, fittings, and wiring devices shall be symmetrical, except as otherwise indicated, and shall not interfere with the work of other trades.

Wall outlet boxes for single or two -gang flush wiring devices shall be not less than 4 inches square and 1-1/2 inches deep. Wall outlet boxes for multiple-gang flush wiring devices shall be not less than 4-1/2 inches wide and 2-1/2 inches deep. Wall-mounted outlet boxes for lighting fixtures and flush devices shall be capable of withstanding a vertical downward force of 50 pounds for a period of 5 minutes.

Boxes shall be formed from carbon-steel sheets of commercial quality, not less than 14-gage. Boxes shall be one-piece construction, zinc- or cadmium-plated in accordance with UL 514A. Boxes and box extension rings shall be provided with knockouts. Boxes shall be designed for mounting flush wiring devices. Boxes shall be flush mounted.

Surface-mounted boxes shall be outside flange type with a matching solid flat cover. Flush-mounted boxes in walls and floors shall be the outside flange type with a matching recessed solid walkway cover. Box bodies and covers shall be galvanized by the hot-dip process in accordance with ASTM A 123/A 123M, Class A.

2.5.2 Cast-Metal Boxes

Cast-metal pull and junction boxes having an internal unobstructed air space of more than 100 cubic inches for connection to galvanized rigid steel conduits embedded in concrete or surface mounted shall be watertight rectangular boxes in accordance with UL 50 and NEMA FB 1.

Box bodies and covers shall be cast with a wall thickness not less than 1/8 inch at every point, of greater thickness at reinforcing ribs and cover edges, and not less than 1/4 inch in thickness at tapped holes for rigid steel conduit. Box bodies shall be provided with integral threaded conduit openings, as required. Mounting lugs shall be provided at the back or at the bottom corner of the box body. Boxes shall be provided with neoprene cover gaskets that will prevent the entrance of water into the enclosure. Covers shall be secured to box bodies with brass or bronze flathead screws.

2.5.3 Pull and Junction Boxes

Pull and junction boxes shall be fabricated from carbon steel and shall conform to UL 50. Box dimensions and conduit connections shall conform to NFPA 70.

Boxes shall be welded construction with flat removable covers fastened to the box with machine screws. Seams and joints at corners or back edges of the box shall be closed and reinforced with flanges formed of the same material from which the box is constructed or by other means such as continuous welding which provides a construction equivalent to integral flange construction.

Boxes intended for outdoor use shall be fiberglass, cast or stainless steel.

2.5.4 RFI-Shielded Enclosures

Radio-frequency interference (RFI)-shielded enclosures shall be provided where indicated to protect electrical equipment from RFI. Enclosures shall have continuously welded seams, exterior mounting and connection facilities, and sealing flanges for hinged doors or screw cover plates equipped with RFI seal gaskets made of woven metallic mesh and neoprene.

PART 3 EXECUTION

3.1 INSTALLATION

Power, lighting, control, emergency light, power, and special-service systems and all related components shall be installed in accordance with NFPA 70, and shall be enclosed in separate conduit or separate conduit systems.

Any run of rigid conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting. Field bends shall be made in accordance with the manufacturer's recommendations. Installed conduit and fittings shall be free of dirt and trash and shall not be deformed or crushed. Empty conduit shall have a pull rope installed.

Conduit shall be installed with a minimum of 3 inches of free air space separation from mechanical piping.

Conduit in finished areas shall be installed concealed. Conduit passing through masonry or concrete walls shall be installed in sleeves.

Conduit shall be securely clamped and supported at least every 10 feet vertically and 8 feet horizontally. Galvanized pipe straps shall be fastened to structure with bolts, screws, and anchors. Wooden masonry plugs shall not be used.

Conduit and boxes shall not be supported from T-bar ceiling wires.

All recessed outlet boxes in non-combustible walls or ceilings shall be installed flush, such that the outlet box is set back less than 1/16-inch or protrudes less than 1/16 inch from the face of the ceiling or wall.

Conduit connections to boxes and fittings shall be supported not more than 36 inches from the connection point. Conduit bends shall be supported not

more than 36 inches from each change in direction. Conduit shall be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs shall be parallel and grouped whenever possible on common supports.

Conduit and raceway runs in damp, corrosive, or outdoor locations, in hazardous areas, where subject to mechanical damage, or intended for conductors rated over 600 volts, shall be rigid steel conduit. Conduit joints in corrosive areas shall be painted with corrosion or acid-inhibiting compounds.

Ends of conduit extending from the interior to the exterior of the building and portions of interior conduit exposed to widely varying temperatures shall be sealed to prevent the passage of air within the conduit. Conduit shall be sloped to drain and shall be provided with drainage fittings at the lower end of the run. Curved portion of conduit bends shall not be visible above the finished floor. Underground service entrance and feeder conduit entering or leaving the building above the ground floor shall be terminated in a pull box.

Exposed ends of conduit without conductors shall be sealed with watertight caps or plugs.

Bushings shall be provided on the open ends of conduit. Insulated bushings shall be provided for conduits containing conductors AWG No. 4 or larger with an insulating ring an integral part of the bushing.

Bonding wires shall be used in all conduit.

Wire or cable shall not be installed in conduit until the conduit system is completed; and the inner surfaces of conduit shall be clean and dry.

A nylon or polypropylene pull rope with a tensile strength not less than 130 pounds shall be installed in empty conduit.

3.1.1 Installation of Rigid Metal Conduit

Ends of conduit shall be cut square, reamed and threaded, and joints shall be brought butt-to-butt in the couplings. Joints shall be mechanically tight. Conduit shall be protected against damage and the entrance of water or foreign material during construction.

Ninety-degree bends of conduit with a diameter larger than 2 1/2 inch shall be made with factory-made elbows. Conduit elbows larger than 2-1/2 inches shall be long radius. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Changes in directions of runs shall be made with symmetrical bends or cast-metal fittings.

At connections to sheet metal enclosures and boxes, a sufficient number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be pulled up sufficiently tight to draw the bushing into firm electrical contact with the box. Conduit shall be fastened to sheet metal boxes and cabinets with two locknuts and insulating bushings shall be used.

Conduit joints shall be made with tapered threads set firmly. Standard coupling should be a straight thread this permits the threads on the conduit to butt in the center of the coupling and provides the maximum contact surface for the electrical continuity. Each length of conduit cut

in the field shall be reamed before installation. Where conduit is threaded in the field, each threaded end shall consist of at least five full threads. Corrosion-inhibitive compound shall be used on conduit threads in exterior areas.

Conduit stubbed up should be rigid metal conduit; transitioning takes place below grade and before the elbow (elbow is rigid).

Where conduit is stubbed-up through concrete floors for connections to free-standing equipment (except motor-control centers, cubicles, and other such items) it shall be provided with a flush coupling if the floor slab is of sufficient thickness; if not, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Installation of Flexible Metallic Conduit

Flexible metallic conduit shall be installed only in exposed, accessible locations and where existing conditions require fishing into walls, in accordance with NFPA 70. A green equipment grounding conductor shall be installed in all runs. Connections to motors and vibrating equipment shall be made with flexible metallic conduit.

Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, metallic transformers, and other approved assemblies. Sections of flexible steel conduit shall be not more than 1800 millimeters except where fished. Ends of flexible steel conduit shall be provided with grounding bushings and approved fittings.

Liquid tight flexible metallic conduits shall be used in wet and oily locations and to complete the connection to motor driven equipment or to adjustable equipment ie. limit switches or valves.

Electrical connections to vibration isolated equipment shall be made with flexible metallic conduit in a manner that will not impair the function of the equipment.

3.2 INSTALLATION OF WIRING

Raceways shall be completely installed, with interiors protected from the weather, before proceeding with the installation of wires and cables. Conductors of special-service systems and emergency light and power systems shall not occupy the same enclosure with light and power conductors or the same enclosure with each other. Conductors shall be continuous with splices and connections made in outlet, junction, or pull boxes only. All control wiring shall be continuous between components and/or terminal boards.

Phase conductors and the neutral conductor of each branch or feeder circuit shall be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electromagnetic induction. Conductors and conduit in parallel shall be the same length and size, shall have conductors of the same type of insulation, shall be terminated at both ends in a manner to ensure equal division of the total current among conductors, and shall have a separate neutral conductor in each conduit.

Sharing of a common neutral between single phase circuits, connected to different phases, shall not be permitted.

Conductors installed in heavy-wall rigid steel conduit and EMT shall have allowable current-carrying capacity and ampere ratings in accordance with NFPA 70. Larger-sized conductors shall be used to compensate for derating factors when more than three current-carrying conductors are installed in raceways and when conductors are installed in wet locations.

Conductors 600 volts and below shall be color coded in accordance with the following:

<u>CONDUCTOR</u>	<u>120/208 COLOR</u>	<u>480/277 COLOR</u>
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	White/Gray
Equipment Grounds	Green	Green

Conductors up to and including AWG No. 2 shall be manufactured with colored insulating materials. Conductors larger than AWG No. 2 shall have ends identified with colored plastic tape in outlet, pull, or junction boxes. Control circuit conductors shall be identified at each connection point.

Connectors and splices shall conform to UL 486C and shall be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection shall be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable. Control-circuit terminals of equipment shall be properly identified by pre-printed heat shrink type markers, or permanently attached metal-foil markers. Cable fittings shall conform to UL 514B; insulating tape shall conform to ASTM D 2301.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation. Tags shall be engraved laminated phenolic, with black lettering, 1/8 inch high, on white background, fastened to cables by means of tie wrap through a hole drilled at one end of the tag.

Grounding shall be provided in accordance with NFPA 70. Noncurrent-carrying parts of electrical equipment shall be bonded and grounded together.

3.3 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall utilizing a minimum of four 1/4-inch bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 5 feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper.

3.4.2 Device Plates

Device plates for switches shall be suitably identified with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 15-ampere, 125-volt, single-phase, duplex, convenience outlets shall be suitably identified, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle.

Device plates for dimmer switches shall be installed in accordance with manufacturer's instructions.

3.5 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Bonding jumpers shall be used around concentric or eccentric knockouts.

Approximate mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be as follows:

<u>LOCATION</u>	<u>MOUNTING HEIGHT</u>
Receptacles in offices	18 inches
Receptacles in corridors	18 inches
Switches for light control	48 inches
Thermostats	66 inches

3.6 IDENTIFICATION LABELS

Yellow identification labels reading CAUTION: 480/277 VOLTS shall be provided in switch and outlet boxes containing 277- or 480-volt circuits. An identification plate marked DANGER: 480 VOLTS shall be provided on the outside of 480-volt enclosures.

Any equipment with multiple sources of power shall be marked as follows:

DANGER - MULTIPLE VOLTAGE SOURCES

3.7 FIELD TESTING

Test reports shall be submitted in accordance with referenced standards in this section.

After completion of the installation and splicing, and prior to energizing the conductors, wire and cable shall be given continuity and insulation tests as herein specified before the conductors are energized.

Necessary test equipment, labor, and personnel shall be provided by the Contractor to perform the tests, as herein specified. Continuity tests shall be conducted using a dc device with bell, buzzer or appropriate continuity tester.

Wire and cable in each voltage classification shall be completely isolated from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Insulation tests on power circuits rated 600-volts and less shall be conducted using a 500- or 1,000-volt insulation-resistance test set. Readings shall be taken for one minute. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. No conductor shall be energized until the installation is approved.

-- End of Section --

SECTION 16275

DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 62 ((1995) Guide for Diagnostic Field Testing of Electric Power Apparatus-Part 1: Oil Filled Power Transformers, Regulators, and Reactors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ST 1 (1988) Specialty Transformers (Except General Purpose Type)

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-2 (2000) How to Buy an Energy-Efficient Distribution Transformer

UNDERWRITERS LABORATORIES (UL)

UL 506 (2004) UL Standard for Safety Specialty Transformers

1.2 GENERAL REQUIREMENTS

Section 16003 GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.

Certification of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, efficiencies and voltage and load losses at rated currents.

Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330 SUBMITTALS PROCEDURES in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall be submitted for distribution transformers:

Connection Diagrams
Fabrication Drawings
Installation Drawings

SD-03 Product Data

Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.

Manufacturer's catalog data shall be submitted for the following items:

Distribution Transformers
Dry-Type Distribution Transformers
Overhead Distribution Transformers
Pad-Mounted Liquid-Filled Distribution Transformers
Pad-Mounted Dry-Type Distribution Transformers

SD-06 Test Reports

Test reports shall be submitted for the following tests on distribution transformers in accordance with the paragraph entitled, "Field Testing," of this section.

Insulating Liquid Tests
Power Factor Tests
Insulation Resistance Tests
Insulation Power Factor (Doble) Tests

SD-07 Certificates

Certification of previous tests on similar units (type-testing) under actual conditions may be submitted for impulse tests, efficiencies, temperature-rise tests, sound tests, power-factor tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Dry-Type Distribution Transformers
Overhead Distribution Transformers
Pad-Mounted Liquid-Filled Distribution Transformers
Pad-Mounted Dry-Type Distribution Transformers

1.4 DRAWINGS

Connection diagrams shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring, and other devices.

Fabrication drawings shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.

Installation drawings shall be submitted for distribution transformers in accordance with the paragraph entitled, "Installation," of this section.

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS

2.1.1 Dry-Type Distribution Isolation Transformer

Specialty dry-type transformers for connection to low-voltage distribution circuits of 600 volts or less and the supply of current for lighting and power loads shall be two-winding, 60-hertz, self-contained, self-cooled, Class AA in accordance with NEMA ST 1 and UL 506.

Insulation system limiting temperature shall be in accordance with the following table, with a temperature rise of:

<u>Dry-Type Class</u>	<u>Maximum Rise by Resistance</u>	<u>Reference Temperature</u>
A	80 degrees C	180 degrees C

The transformer windings shall be copper with a 480 volt (delta) primary and a 120/208 V Y (wye) grounded secondary.

2.1.2 Efficiencies

Distribution transformers shall have efficiencies in accordance with the recommended levels specified in DOE CI-2.

2.2 FACTORY FINISH

Transformers shall be provided with the manufacturer's standard paint finish when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09960 HIGH PERFORMANCE COATINGS.

PART 3 EXECUTION

3.1 INSTALLATION

Dry type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.

Pad-mounted distribution transformers shall be installed on precast or poured-in-place concrete pads and shall be grounded to a ground grid.

Provisions shall be made for forced cooling and related requirements. Voltage and kilovolt-ampere (kVA) ratings shall be as noted.

Each overhead and pad-mounted distribution transformer shall have its kVA rating conspicuously displayed in 3-inch high yellow letters on its tank or enclosure in addition to the complete manufacturer's standard

identification plate.

3.2 FIELD TESTING

Transformers shall be tested in accordance with IEEE Std 62.

3.2.1 Insulation-Resistance Tests

Transformer windings shall be given an insulation-resistance test using the following test set versus voltage level criteria:

Dry type 480- to 600-volt transformers - 1,000-volt test set

Dry type 240-volt and below transformers - 500-volt test set

Liquid type 2.4-kilovolt transformers - 2500-volt test set (primary)

Liquid type 15-to 5-kilovolt transformers - 5000-volt test set (primary)

3.2.2 Acceptance

Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 16446

PANELBOARDS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

FEDERAL STANDARDS (FED-STD)

FED-STD 595 (Rev B) Colors Used in Government Procurement

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 250 (1991) Enclosures for Electric Equipment (1000 Volts Maximum)

NEMA AB 1 (1994) Molded Case Circuit Breakers and Molded Case Switches

NEMA PB 1 (1990) Panelboards

UNDERWRITERS LABORATORIES (UL)

UL 67 (1993; 11th Ed) Panelboards

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Panelboards

SD-04 Drawings

Detail Drawings shall be submitted for the Panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Drawings shall

include details of bus layout.

SD-04 Drawings

Outline Drawings for Panelboards shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-06 Instructions

Manufacturer's Instructions shall be submitted for Panelboards including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

SD-09 Reports

Test Reports shall be submitted for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Panelboards shall not be energized until the recorded test data have been submitted to and approved by the Contracting Officer.

Continuity Tests
Insulation Tests

SD-14 Samples

Keys shall then be properly tagged and delivered to the Contracting Officer.

PART 2 PRODUCTS

2.1 PANELBOARDS

Power-distribution panelboards and lighting and appliance branch-circuit panelboards shall be totally enclosed in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Panelboards shall conform to NEMA PB 1 and NEMA AB 1. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on panelboards to provide gutter space access. A center door shall be provided for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Four-wire distribution panelboards and lighting and appliance branch-circuit panelboards shall be provided with an isolated full-capacity neutral bus. Panelboards shall be rated for 240-volt (maximum), single-phase or 120/208-volt, three-phase or 277/480-volt, three-phase, 60-hertz current as indicated on the panelboard schedules or as indicated on the one-line diagrams.

Three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards shall be provided with an isolated full-capacity bus for single-pole circuit breakers/switches and spaces .

Panelboards shall be provided with a separate grounding bus bonded to the

enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Panelboards and main lugs or main breaker shall have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that any two adjacent single-pole breakers are connected to opposite phases and two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard box shall be galvanized code-gage sheet steel without knockouts. Entire panelboard front shall be hinged on one side with a piano hinge for the full height and shall also have captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces.

Panelboards shall be finished with baked enamel. Finish color shall be No. 61 gray conforming to FED-STD 595 except that color of the finished coat of trim and front shall match the adjacent walls. Field painting of the trim and front shall be as specified in Section 09915, "Painting".

Panelboard enclosures shall be NEMA 250, Type 1 unless indicated otherwise. Enclosures shall be provided with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Locks shall be keyed alike, and two keys shall be provided for each enclosure.

2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 16286, "Overcurrent Protective Devices." Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208-volt panelboards shall be not less than 10,000 amperes rms symmetrical for lighting and 22,000 for power panels, and that for breakers in 277/480-volt panelboards shall be not less than 22,000 amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type shall not be acceptable.

Shunt trips shall be provided where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single-pole 15- and 20-ampere circuit breakers shall be UL listed as "SWD" (for switching fluorescent lighting loads, and as "HACR" for use with HVAC equipment) at 120 volts ac or 277 volts ac as indicated. UL Class A (5-milliampere sensitivity) ground fault circuit protection shall be provided on 120-volt ac branch circuit as indicated. This protection shall be an integral part of the branch circuit breaker that also provides overload and short-circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single-pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional single pole circuit breaker.

Connections to the bus shall be bolt-on type.

When multiple wires per phase are specified, the circuit breakers shall be furnished with connectors UL Listed to accommodate multiple wires.

Circuit breaker spaces called out on the drawings shall be complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

A directory card shall be mounted on the inside of hinged fronts and doors in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Complete panelboards shall be tested in accordance with UL 67.

PART 3 EXECUTION

3.1 INSTALLATION

Panelboards shall be installed as indicated and in accordance with the manufacturer's instructions. Panels shall be fully aligned and mounted so that the height of the top operating handle will not exceed 72-inches above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate spares, spaces for future and description of load controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Test equipment, labor, and personnel shall be provided by the Contractor as

required to perform the tests as specified. Continuity tests shall be conducted using a dc device with bell or buzzer.

Insulation tests on 480-volt panelboards shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be recorded every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Insulation tests on panelboards rated 300 volts or less shall be conducted using a 500-volt minimum insulation-resistance test set. Readings shall be recorded after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Test data shall be recorded and shall include the location and identification of panelboards and megohm readings versus time.

Phase rotation test shall be performed on all 3-phase panelboards.

-- End of Section --

SECTION 16511

FLUORESCENT LUMINAIRES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- | | |
|------------|---|
| ANSI C78.1 | (1991; C78.1a-1992) Dimensional and Electrical Characteristics of Fluorescent Lamps - Rapid Start Types |
| ANSI C82.1 | (1985; C82.1a-1990; c82.1b-1990; C82.1c-1990) Ballasts for Fluorescent Lamps |
| ANSI C82.2 | (1984; R 1989) Fluorescent Lamp Ballasts - Methods of Measurement |

FEDERAL COMMUNICATIONS COMMISSION (FCC)

- | | |
|-------------|---------------------|
| FCC Part 18 | RF Lighting Devices |
|-------------|---------------------|

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

- | | |
|----------|--|
| NEMA 270 | (1988) Procedure for Fluorescent Lamp/Ballast/Fixture Performance Comparison |
|----------|--|

UNDERWRITERS LABORATORIES (UL)

- | | |
|---------|---|
| UL 1570 | (1988; 3rd Ed; Rev thru May 25, 1990) Fluorescent Lighting Fixtures |
| UL 844 | (1995; 11th Ed) UL Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations |
| UL 935 | (1995; 9th Ed) Fluorescent-Lamp Ballasts |

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Fluorescent fixture performance requirements shall be rated in accordance with NEMA 270.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for the following including life, test, system functional flows, safety features, and mechanical automated details.

Fluorescent Lighting Fixtures
Fluorescent Lamp Ballast
Fluorescent Lamps

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Fluorescent Lighting Fixtures
Fluorescent Lamp Ballast
Fluorescent Lamps
Accessories

SD-09 Reports

Test Reports shall show compliance with the requirements of this specification as follows:

Lighting-Distribution Curves for each type of fixture shall be prepared utilizing the fixture manufacturer's own facilities or those of an independent nationally recognized laboratory, in accordance with the standard procedure developed by the Illuminating Engineering Society.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Fluorescent lighting fixtures shall conform to UL 1570 and as specified. Fixtures in hazardous areas shall conform to UL 844.

Lighting fixtures shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Recessed fixtures in suspended ceilings shall be designed and equipped for installation in the type of ceiling in which the fixture is to be installed. Fixtures shall be designed to be supported independent of the ceiling and shall be equipped with the lamps indicated.

2.2 COMMERCIAL FIXTURES

Commercial fluorescent lighting fixtures shall conform to UL 1570 and include recessed, surface-mounted, and pendant-mounted luminaires as indicated and herein specified.

Lighting fixtures shall include wiring channel, end plates, end caps, side panels, top reflectors, bottom closures, lampholders, lamps, ballasts, suspension stems, wiring, and other necessary materials and devices.

Ballasts and wiring shall be completely enclosed in the wiring channel and shall be easily accessible. Ballast shall be replaceable without removing the fixture from its mounting. Lamps shall be replaceable without the use of tools and without removal of other lamps and equipment.

Wiring channel, end plates, and other sheet steel enclosure components shall be cold-rolled carbon-steel sheet of commercial quality not less than 20 gage.

When two or more fixtures are joined together in continuous rows, the wiring channel shall form an open and continuous wireway.

2.2.1 Recessed Fixtures

Recessed fixtures in suspended ceilings shall be equipped with frames, yokes, and adjustable mounting brackets designed for the type of ceiling construction in which the fixture is to be installed. Bottom closure shall be hinge framed with chromium or nickel-plated latching devices.

2.3 FLUORESCENT LAMP BALLAST

Fluorescent lamp ballasts shall be Class P in accordance with ANSI C82.1, ANSI C82.2, and UL 935.

Ballasts shall be designed for two-lamp operation with line power factor not less than 90 percent. Two-lamp ballasts shall operate the two lamps out of phase with each other. Lamp cathodes shall be continuously heated during lamp operation.

Fluorescent lighting fixtures with lamps 30 watts or more shall be equipped with rapid-start ballasts. All fluorescent lighting fixtures with lamps rated 20 watts or less shall be equipped with trigger-start ballasts. Auxiliary lamp starters shall not be permitted.

Ballasts shall be voltage rated for operation on 120-volt, single-phase, 60-hertz lighting distribution systems as indicated.

Ballasts shall be designed for a maximum ambient temperature of 105 degrees F.

Ballasts for indoor lamps shall be in accordance with UL 935 .

Ballasts for outdoor lamps shall have a minimum starting temperature of minus 0 degrees F.

2.3.1 Electronic Ballasts

Ballasts shall not contain polychlorinated biphenyls (PCB's).

Ballasts shall operate with a 90 to 110 percent input voltage variation at an input frequency of 60 Hz. Light output shall remain constant for line voltage fluctuations of plus or minus 3 percent. Ballasts shall be rapid start type.

Ballasts shall have a minimum power factor of 0.95.

Ballasts shall comply with Class A (20-24 DB) sound rating.

Ballasts shall comply with Electromagnetic Interference (EMI) and Radio Interference (RFI) limits set by the FCC Part 18, CFR, Chapter 18, Part C.

Ballasts shall have less than 10 percent Total Harmonic Distortion.

Ballasts for rapid start T-8 lamps shall be capable of operating remaining lamps if one or more companion lamps fail or are removed.

Ballast size and mounting configuration shall be consistent with standard electromagnetic ballast for same application.

2.4 FLUORESCENT LAMPS

Lamps shall conform to ANSI C78.1 and shall be the energy-efficient type with a minimum starting temperature of 60 degrees F.

2.4.1 Rapid Start Lamp

The 32-watt, extra-high efficiency fluorescent lamp shall have a minimum efficiency of 91 lumens per watt and shall be designed to operate on a two-lamp, electronic ballast.

Rapid start lamps shall have bulb designation T-8 and a base configuration of medium bipin contact.

Lamps shall have an average rated life at 3 hours per start of 20,000 hours.

Bulb color temperature shall be 3500K [Daylight]. Lamp dimensions shall be in accordance with ANSI C78.1.

Acceptable Fluorescent Rapid Start 48 inches (T8) lamps are:

GTE type F32T8/SPX35, 32W, 2950 Lumens, 3500K, Trimline Series
Sylvania type FBO32/835/6, 32W, 3000 Lumens, 3500K, Octron Series
Philips type F32T8/TL835, 31W, 2800 Lumens, 3500K, TL Series

Acceptable Fluorescent Rapid Start U6 (T8) lamps are:

GTE type F32T8/SPX35/U/6,, 31W, 2800 Lumens, 3500K
Sylvania type FBO32/835/6, 32W, 3000 Lumens, 3500K
Philips type F31T8/TL835, 31W, 2800 Lumens, 3500K

2.5 FLUORESCENT FIXTURE LENS

All 24" X 48", 24" X 24", and 12" X 48" lensed fluorescent light fixture shall have a diffuser made of clear color stabilized "K-12" (0.125") low brightness acrylic material except in areas using video terminals.

PART 3 EXECUTION

3.1 INSTALLATION

Fluorescent fixtures shall be installed in accordance with UL 1570.

A fixture shall be installed at each outlet indicated, and lamps of the proper type and wattage shall be installed in each fixture.

New lamps shall be installed immediately prior to completion of the project.

Supports for recessed fixtures shall have a minimum capacity of 150 pounds, and all parts of the support shall be arranged to prevent them from vibrating free.

Supports for recessed fixtures in suspended ceilings shall be so arranged that each corner of each fixture is supported by a hanger wire anchored to a structural member or to the structure to afford adequate seismic anchorage.

Surface-mounted fixtures shall be attached securely to structural members or to metal supports that span structural members. Fixtures shall be fastened near each end and, when over 4-feet long, shall also be fastened at the center. When surface-mounted fixtures are not UL approved for direct mounting on combustible ceilings, suitable spacers shall be installed.

Fixtures located in equipment rooms shall be so installed that they clear all obstructions such as duct, piping, bracing, and supports.

3.2 FIELD TESTING

Fluorescent lighting fixtures shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

Date Generated:			SUBMITTAL REGISTER					CONTRACT NO.				
Project Title: Research Laboratory, Room 317, BLDG. 77			Location:		Contractor:					Lead Designer:		
TRANS CONTROL NO	SPEC SECTN NO.	SD NO. AND TYPE OF SUBMITTAL MATERIAL OR PRODUCT	SPEC PARA NO.	GOVT OR A/E REVIEWER	DATE DUE FROM CONTRCTR	DATE RCV FROM CONTRCTR	APPROVING AUTHORITY ACTION			DATE DUE BACK TO CONTRCTR	DATE MLD TO CONTRCTR	REMARKS
							DATE FRM LEAD TO REVIEWER	DATE FRM. REVIEWER TO LEAD	ACT CODE			
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	01110	SD-01 Preconstruction Submittals										
		Utility Outages										
		Connection Requests										
		Welding Permits										
		Laser Permits										
		Safety Permits										
		Hot Work Permits	1.9.3									
	01315	SD-01 Preconstruction Submittals										
		Project Submittal Schedule	1.5									
	01411	SD-06 Test Reports										
		Gas Protection	1.12									
	01411	SD-07 Certificates										
		Site-Specific Health and Safety Plan	1.3.1									
	01750	SD-06 Test Reports										
		Factory Tests	1.2.2									
		Functional Test	1.2.3									
		Final Acceptance Test	1.2.4									
		Test Procedures	1.2.5									
	01780	SD-01 Preconstruction Submittals										
		Reproducible Drawings										
		CAD System Drawings										
	01780	SD-02 Shop Drawings										
		As-Built Drawings	1.4									
	01780	SD-03 Product Data										
		Spare Parts Data	1.4									
	01780	SD-07 Certificates										
		Work Plan	1.4									
	01780	SD-08 Manufacturer's Instructions										
		Preventative Maintenance	1.4									
		Condition Monitoring (Predictive	1.4									
		Testing)										
		Inspection	1.4									

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Project Title:			Location:		Contractor:					Lead Designer:		
Research Laboratory, Room 317, BLDG. 77												
TRANS CONTROL NO	SPEC SECTN NO.	SD NO. AND TYPE OF SUBMITTAL MATERIAL OR PRODUCT	SPEC PARA NO.	GOVT OR A/E REVIEWER	DATE DUE FROM CONTRCTR	DATE RCV FROM CONTRCTR	APPROVING AUTHORITY ACTION			DATE DUE BACK TO CONTRCTR	DATE MLD TO CONTRCTR	REMARKS
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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	01780	Posted Instructions	1.4									
	01780	SD-10 Operation and Maintenance										
		Data										
		Operation and Maintenance	3.1									
		Manuals										
	04225	SD-07 Certificates										
		Concrete Masonry Units	2.1									
		Mortar	2.2									
	05120	SD-02 Shop Drawings										
		Fabrication Drawings	1.8									
		Structural Steel	1.8									
		Structural Steel	2.1									
	05120	SD-07 Certificates										
		Welding Procedures	1.4									
		Welder Qualifications	1.4									
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	07920	SD-03 Product Data										
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		Bond-Preventative Material	2.2									
		Primer	2.3									
		Oil and Resin-Based Sealants										
		Elastomeric Sealants	2.4.1									
		Latex Sealants	2.4.2									
		Solvents and Cleaning Agents	2.5									
	07920	SD-04 Samples										
		Sealing Compound	1.2.1									
		Labels	1.2.1									
		Backup Material	1.2.1									
	07920	SD-07 Certificates										
		Flexible Cellular Backing	2.1.1									
		Bond-Preventative Material	2.2									

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	07920	Primer	2.3									
		Solvents and Cleaning Agents	2.5									
	07920	SD-08 Manufacturer's Instructions										
		Manufacturer's Installation	2.4									
		Thermoplastic Sealing Compound	2.4									
		Two-Component Elastomeric	2.4									
		Sealant										
	08100	SD-02 Shop Drawings										
		Frames	2.1.1									
	08100	SD-03 Product Data										
		Frames	2.1.1									
		Finish Hardware	2.2									
		Reinforcement	2.2									
	08100	SD-07 Certificates										
		Frames	2.1.1									
	08210	SD-03 Product Data										
		Fire Rated Labeled Doors	2.1.1									
		Thresholds	2.7									
	08300	SD-03 Product Data										
		Cleanroom Sliding Door										
		Thresholds										
	08300	SD-02 Shop Drawings										
		Cleanroom Sliding Doors										
	08710	SD-01 Preconstruction Submittals										
		Finish Schedule	1.3									
		Hardware Schedule	1.3									
		Material, Equipment and Fixture	1.3									
		Lists										
		Finish Hardware	1.3									
	08710	SD-03 Product Data										
		Fasteners	2.1									
		Hinges	2.2									

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	08710	Locksets	2.3									
		Exit Devices	2.4									
		Thresholds	2.6									
		Closers	2.7									
		Door Holders										
		Door Stops	2.9.2									
		Door Silencers										
		Metal Kick Plates	2.9.3									
		Door-Sill and Jamb Sound Control System										
	08710	SD-08 Manufacturer's Instructions										
		Manufacturer's Instructions	1.3									
	09260	SD-03 Product Data										
		Gypsum Wallboard	2.1.3									
		Furring	2.1.6.2									
		Hangers and Inserts	2.1.6.1									
		Suspension	2.1.6.2									
		Channels	2.1.6.2									
		Resilient Channels	2.1.6.3									
		Joint Tapes	2.1.4.1									
		Steel-Stud Framing	2.1.6.4									
		Metal-Framed Drywall Ceilings	3.2.18.1									
		Fasteners	2.1.5									
		Adhesives	2.1.4.2									
		Floor and Ceiling Runners	2.1.6.4									
	09514	SD-02 Shop Drawings										
		Installation Drawings	1.7									
	09514	SD-03 Product Data										
		Fire-Rated Ceiling Systems										
		Acoustic Materials	2.1									
		Suspension System Materials	2.2									
		Suspension Materials										

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	09514	SD-04 Samples										
		Acoustic Units	1.7									
		Suspension System Members	1.7									
		Anchorage Devices and Fasteners	1.7									
	09514	SD-08 Manufacturer's Instructions										
		Acoustic Materials	2.1									
		Suspension System Materials	2.2									
		Manufacturer's Instructions	1.6									
	09675	SD-03 Product Data										
		Epoxy-Resin Binder/Matrix	2.2.1									
		Surface Sealing Coat	2.2.2									
	09675	SD-04 Samples										
		Hardboard Panels	1.4.2									
	09675	SD-05 Design Data										
		Epoxy-Resin Binder/Matrix	2.2.1									
		Surface Sealing Coat	2.2.2									
	09675	SD-06 Test Reports										
		Records of Inspection	1.4									
	09915	SD-01 Preconstruction Submittals										
		Manufacturer's Catalog Data										
		Paint Materials										
		Certificates of Compliance										
		Paint Materials										
		Manufacturer's Standard Color										
		Charts										
		Paint Materials										
	13282	SD-02 Shop Drawings										
		Vacuum filters	1.7.4									
		Respirators	1.7.1									
	13282	SD-06 Test Reports										
		Chemicals	2.1									
		Materials	2.2									

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	13282	Material safety data sheets	2.1									
	13282	SD-08 Manufacturer's Instructions										
		Qualifications of CP	1.5.3.1									
		Testing laboratory and consultant	1.5.3.2									
		Lead based paint removal plan	1.5.3.3									
		Rental equipment notification	1.7.3									
		Respiratory protection program	1.3.4									
		Hazard communication program	1.3.5									
		disposal facility	3.2.5									
		Hazardous waste management plan	1.3.6									
	13282	SD-09 Manufacturer's Field Reports										
		Sampling results	1.5.4.1									
		Vacuum filters	1.7.4									
		manifest	3.2.5									
		medical examinations	1.3.1									
		training certification	1.3.3.1									
	13930	SD-03 Product Data										
		Piping Materials										
		Valves										
		Sprinkler Heads										
		Miscellaneous Materials	2.5									
		Supporting Elements	2.3									
	13930	SD-06 Test Reports										
		Pressure Tests	3.7.2									
	15050	SD-02 Shop Drawings										
		As-Built Drawings										
		Connection Diagrams										
	15050	SD-03 Product Data										
		Pipe and Fittings	2.1									
		Piping Specialties										
		Valves										
		Equipment Foundation Data										

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	15050	SD-06 Test Reports										
		Hydrostatic Tests	3.1									
		Pneumatic Tests	3.1									
		System Operation Tests	3.1									
	15050	SD-10 Operation and Maintenance										
		Data										
		Operation and Maintenance	3.7									
		Manuals										
	15083	SD-03 Product Data										
		Adhesives	2.1.1									
		Coatings	2.1.2									
		Thermal-Insulation Materials	2.1.3									
		Jacketing Materials										
	15815	SD-02 Shop Drawings										
		Fabrication Drawings	1.4									
		As-Built Drawings	1.4									
	15815	SD-03 Product Data										
		Galvanized Steel Ductwork	2.1									
		Materials										
		Flexible Duct Materials	2.2									
		Flexible Connectors										
		Fire Dampers and Wall Collars	2.5									
		Gravity Backdraft and Relief	2.4									
		Dampers										
		Manual Volume Dampers	2.3									
		Access Doors										
	15815	SD-04 Samples										
		Manufacturer's Standard Color										
		Chart										
	15815	SD-06 Test Reports										
		Operation Tests	3.9									
		Ductwork Leakage Tests	3.10									

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	15815	SD-10 Operation and Maintenance										
		Data										
		Operation and Maintenance	3.11									
		Manuals										
		Fire Dampers and Wall Collars	2.5									
	15902	SD-01 Preconstruction Submittals										
		Material, Equipment, and Fixture	1.2									
		Lists										
		Records of Existing Conditions										
	15902	SD-02 Shop Drawings										
		Installation Drawings										
	15902	SD-03 Product Data										
		Control Components	2.1									
		Thermometers										
		Pressure Gages										
		Valves	2.2									
		Dampers	2.5.2									
		Operators	2.5.1									
		Operators	2.5.3									
		Operators	2.5.4									
	15902	SD-04 Samples										
		Thermostat Covers										
		Thermostat Guards										
		Room Humidistats										
	15902	SD-06 Test Reports										
		Test reports										
	15902	SD-07 Certificates										
		Listing of Product Installations										
	15902	SD-08 Manufacturer's Instructions										
		Operating Instructions	1.3									
	15902	SD-10 Operation and Maintenance										
		Data										

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	15902	Operation and Maintenance	3.5									
		Manuals										
		Pneumatic Operators	2.5.3									
	15950	SD-03 Product Data										
		Equipment and Performance Data	1.3									
	15950	SD-06 Test Reports										
		Test Reports	1.3									
	15950	SD-07 Certificates										
		Certificates	1.3									
	16050	SD-01 Preconstruction Submittals										
		Material, Equipment, and Fixture	1.4									
		Lists										
		Conduits, Raceway sand Fittings	3.1									
		Wire and Cable	2.2									
		Splices and Connectors	2.3									
		Switches	2.4									
		Receptacles	2.5									
		Receptacles	3.3.1									
		Outlets, Outlet Boxes, and Pull	2.6									
		Boxes										
		Circuit Breakers	2.8									
		Panelboards	2.7									
		Panelboards	3.6									
		Lamps and Lighting Fixtures	2.9									
		Lamps and Lighting Fixtures	3.5									
		Dry-Type Distribution Transformers	3.7									
	16050	SD-03 Product Data										
		Conduits, Raceway sand Fittings	3.1									
		Wire and Cable	2.2									
		Splices and Connectors	2.3									
		Switches	2.4									
		Receptacles	2.5									

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	16050	Receptacles	3.3.1									
		Outlets, Outlet Boxes, and Pull Boxes	2.6									
		Circuit Breakers	2.8									
		Panelboards	2.7									
		Panelboards	3.6									
		Lamps and Lighting Fixtures	2.9									
		Lamps and Lighting Fixtures	3.5									
		Dry-Type Distribution Transformers	3.7									
		Spare Parts	1.3									
	16050	SD-06 Test Reports										
		Continuity and Insulation Resistance Test	3.10									
		Phase-Rotation Tests	3.10									
		Insulation Resistance Test	3.10									
	16050	SD-08 Manufacturer's Instructions										
		Manufacturer's Instructions	1.4									
	16145	SD-01 Preconstruction Submittals										
		Conduit, Raceways and Fittings	2.1	G								
		Wire and Cable	2.2	G								
		Safety Switches	2.3	G								
		Flush Wiring Devices	2.4	G								
		Boxes and Fittings	2.5	G								
		Communication Cabinets		G								
	16145	SD-02 Shop Drawings										
		Fabrication Drawings	1.4									
		Assembly Drawings	1.4									
	16145	SD-03 Product Data										
		Conduit, Raceways and Fittings	2.1	G								
		Wire and Cable	2.2	G								
		Safety Switches	2.3	G								
		Flush Wiring Devices	2.4	G								

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(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)
	16145	Boxes and Fittings	2.5	G								
		Communication Cabinets		G								
	16145	SD-06 Test Reports										
		Test Reports	3.7									
	16275	SD-02 Shop Drawings										
		Connection Diagrams	1.4									
		Fabrication Drawings	1.4									
		Installation Drawings	1.4									
	16275	SD-03 Product Data										
		Equipment and Performance data	1.2									
		Equipment Foundation Data	1.2									
		Distribution Transformers	2.1.2									
		Dry-Type Distribution Transformers										
		Overhead Distribution Transformers										
		Pad-Mounted Liquid-Filled										
		Distribution Transformers										
		Pad-Mounted Dry-Type Distribution										
		Transformers										
	16275	SD-06 Test Reports										
		Insulating Liquid Tests										
		Power Factor Tests										
		Insulation Resistance Tests	3.2.1									
		Insulation Power Factor (Doble)										
		Tests										
	16275	SD-07 Certificates										
		Certification	1.2									
	16275	SD-10 Operation and Maintenance										
		Data										
		Dry-Type Distribution Transformers										
		Overhead Distribution Transformers										
		Pad-Mounted Liquid-Filled										
		Distribution Transformers										

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	16275	Pad-Mounted Dry-Type Distribution Transformers										
	16446	SD-01 Preconstruction Submittals										
		Manufacturer's Catalog Data										
		Panelboards										
	16446	SD-04 Samples										
		Detail Drawings										
		Panelboards										
		Outline Drawings										
		Panelboards										
	16446	SD-06 Test Reports										
		Manufacturer's Instructions										
		Panelboards										
	16446	SD-09 Manufacturer's Field Reports										
		Test Reports										
		Continuity Tests										
		Insulation Tests										
	16511	SD-01 Preconstruction Submittals										
		Equipment and Performance Data										
		Fluorescent Lighting Fixtures										
		Fluorescent Lamp Ballast										
		Fluorescent Lamps										
		Manufacturer's Catalog Data										
		Fluorescent Lighting Fixtures										
		Fluorescent Lamp Ballast										
		Fluorescent Lamps										
		Accessories										
	16511	SD-09 Manufacturer's Field Reports										
		Test Reports										
		Lighting-Distribution Curves										